# The Sizewell C Project

## 6.3 Volume 2 Main Development Site
## Chapter 14 Terrestrial Ecology and Ornithology
### Appendix 14B2 Ornithology Synthesis Report


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# 1 Ornithology Synthesis Report

## 1.1 Introduction

### a) Purpose of the Synthesis Report

1.1.1 SZC Co. is to submit an application for a Development Consent Order (DCO) to construct and operate a new nuclear power station, Sizewell C (hereafter referred to as SZC), near the town of Leiston in Suffolk. The site lies within an area of high landscape and ecological sensitivity, is partly within the Suffolk Coast and Heaths Area of Outstanding Natural Beauty (AONB), and also extends into the Outer Thames Estuary Special Protection Area (SPA). A small part also lies within the Sizewell Marshes Site of Special Scientific Interest (SSSI). The site is also adjacent to the Minsmere to Walberswick Heaths and Marshes SSSI, Special Area of Conservation (SAC) and Minsmere-Walberswick SPA and Ramsar site, as well as the Sandlings SPA.

1.1.2 The Terrestrial Ecology and Ornithology Chapter for the Environmental Statement (ES) of the Sizewell C Main Development Site (hereafter referred to as the Main Development Site) is supported by a number of appendices, which set out the detail of the Ecological Impact Assessment (EcIA) process.

1.1.3 'Synthesis Reports' for two topics (Plants and Habitats and Ornithology (this document)) have been produced to provide further detail on the evidence base underpinning the impact assessment. The reason for the focus on these two topics is that a significant proportion of the effects arising from the development of Sizewell C will be pertinent to these ecological features, and also because habitats and birds comprise the majority of the qualifying features of those European sites that are within the Zone of Influence (ZoI) of the Project. Therefore, a necessarily larger body of evidence has been required for these topics in order to underpin the EcIA and the Habitats Regulations Assessment (HRA).

1.1.4 The Synthesis Reports bring together the following detailed information that has been collected in order to inform and support the HRA and Environmental Impact Assessment (EIA) processes:

- Information from available scientific (published and unpublished) literature providing evidence of the likely response of Important Ecological Features (IEFs) to the effects of the Sizewell C Project.

- The results of related studies and modelling undertaken to inform specific aspects of the effects of the Sizewell C Project (e.g. analysis of potential impact pathways).

- Information that has formed part of the extensive scoping and consultation process carried out with key stakeholders.

1.1.5 The Synthesis Reports do not attempt to describe all potential effects and associated impact pathways (only those considered most relevant are discussed), and no element of scoping, valuation or assessment is included here. This information is instead presented in the ES chapter and Shadow HRA.

1.1.6 The Synthesis Reports do not present a detailed description of the Sizewell C Project (including the permanent and temporary development), nor do they set out the mitigation measures that are considered to be part of the project (both primary (i.e. 'embedded') and tertiary (i.e. standard construction practice) mitigation). This information, as well as detailed ecological baseline information, is provided in detail in the ES.

### b) Structure of this report

1.1.7 This Ornithology Synthesis Report is structured to present information collected to inform and support both the Shadow HRA and EIA as follows:

- **Section 1** sets the context and purpose of the Synthesis Reports.
- **Section 2** summarises the pathways for effect on ornithological receptors.
- **Section 3** provides a summary of the receptors of relevance to both the Shadow HRA and EIA.
- **Section 4** provides a summary of the evidence base used for assessing the potential pathways for effect on ornithological interests, with reference to the scientific literature and project-specific studies undertaken to inform the impact description and characterisation for both the HRA and EIA.
- **Section 5** lists the references cited within this report.
- The following appendices provide supporting evidence to this Synthesis Report: **Appendix 1** (outputs of construction noise modelling and potential visual impact zones), **Appendix 2** (evidence base for potential effects of anthropogenic disturbance on breeding and wintering waterbirds) and **Appendix 3** (evidence base for potential effects of anthropogenic disturbance on marsh harrier).

## 1.2 Summary of pathways for effect

### a) Effect pathways

1.2.1 **Table 2.1** below details the environmental 'effects' categories which could occur during the construction, operation and decommissioning phase of the Sizewell C Project. The judgement as to whether a significant effect or impact is likely has been based on the best readily available information. As detailed in **Table 2.1**, the potential effect pathways as a result of the Sizewell C Project can be summarised as:

- Alteration of coastal processes / sediment transport (construction, operation and decommissioning).
- Water quality effects – marine environment (construction, operation and decommissioning).
- Water quality effects – terrestrial environment (construction, operation and decommissioning).
- Alteration of local hydrology and hydrogeology (construction, operation and decommissioning).
- Changes in air quality (construction, operation and decommissioning).
- Direct habitat loss and fragmentation (construction, operation and decommissioning).
- Disturbance effects on species populations (construction, operation and decommissioning).
- Disturbance due to increased recreational pressure (construction, operation and decommissioning).
- Physical interactions between species and Project infrastructure (operation only).

### Table 1.1: Potential effect / impact pathways

| Category | Definition | |
|---|---|---|
| | Construction / decommissioning | Operation |
| Alteration of coastal processes / sediment transport | This includes the potential for erosion, accretion and sedimentation (short and long term). The focus is largely on indirect effects (rather than direct effects which are covered under 'Direct habitat loss and fragmentation'). This distinction has been made to avoid the double counting of effects. | As for construction. |
| Water quality effects – marine environment. | This covers potential thermal and chemical (non-radiological and radiological) effects on water quality and indirect effects on habitats and species (including prey species), as well as water quality effects due to change in suspended sediment concentrations (SSC) (it does not include sedimentation, which is covered as part of 'Alteration of coastal processes / sediment transport'). | As for construction, but also:<br>• chlorination effects associated with the management of organisms in the cooling water intake; and,<br>• the implications of the discharge from the fish recovery and return system. |
| Water quality effects – terrestrial environment. | This covers potential supporting parameters and chemical effects on freshwater (surface and groundwater) – such as SSC and nutrient concentrations in addition to chemical status – as well as any potential indirect effects on habitats and species.<br>Any foul water flows would be treated to ensure water quality effects are controlled. | This covers potential changes in supporting parameters (e.g. long-term flow changes associated with the cut-off wall and realignment of ditches), as well as any consequential indirect effects on habitats and species.<br>No chemical effects are predicted during the operational phase in this context (as all discharge would be via the cooling water system). |
| Alteration of local hydrology and hydrogeology. | This covers potential physical effects on freshwater (including surface and groundwater resources), i.e. effects on flows and water levels, as well as any consequential indirect effects on habitats and species. | As for construction. |
| Changes in air quality. | This covers changes in air quality through radioactive and non-radioactive emissions to air and any consequential direct or indirect effects on habitats and species (e.g. lichens). | As for construction. |

| Category | Definition | |
|---|---|---|
| | Construction / decommissioning | Operation |
| | Potential non-radiological air quality effects have been considered where the site is within 10 km of the main development site (and not considered beyond this distance). Note: the ZoI for particulate (dust) emissions is generally much smaller than this (<200 m from the emission source). | |
| Direct habitat loss and fragmentation. | This effect is limited to direct effects on habitats (not species). Indirect effects are covered elsewhere, as noted above. | As for construction. |
| Disturbance effects on species populations. | This effect is limited to potential disturbance effects on target species (not habitats), e.g. noise, light and human activity, and includes species displacement. Potential recreational effects are covered separately below. | As for construction. |
| Disturbance due to increased recreational pressure. | Potential effects due to increased recreational pressure have been considered where the European site in question is within the ZoI of potential recreational effects. That is:<br>• Zone of Physical Change – a 2 km area around main development site.<br>• Displacement Zone – an 8 km area around main development site.<br>• Buffer Zone – an 8 km area around settlements within the Displacement Zone.<br>Potential effects include trampling of supporting habitat, as well as disturbance effects to species and populations. | The potential for disturbance due to increased recreational pressure is considered to be of a lesser magnitude during the operational phase due to the large reduction in the number of workers required for this phase. |
| Physical interactions between species and Project infrastructure. | This pathway for effect has not been identified during the construction or decommissioning phases. | Potential direct or indirect effects on qualifying features due to interactions (e.g. collisions) with the infrastructure or machinery associated with the Project. Indirect effects could arise via effects on prey species (e.g. impingement and entrainment of small fish and their larvae and eggs). |

## 1.3 Summary of receptors

### a) European sites and relevant qualifying interest features

1.3.1 For an effect on a receptor (in this case a 'qualifying feature' of a European site) to occur, the receptor needs to be sensitive to the change that would occur as a result of the activity and vulnerable to the effect (i.e. within the impact zone). This zone can be determined based on a number of methods, including modelling, to predict the direct and indirect area of effect, or ZoI, of the activity.

1.3.2 A 'scoping' process has been undertaken to determine the European sites and features which could be influenced by the effects of the Project as a first step.

1.3.3 Based on existing knowledge, it is possible to 'screen' out the potential for some effects to occur on certain qualifying features either because they would not be vulnerable to any changes occurring as a result of the Sizewell C Project and/or they would not be sensitive to any changes that could occur. This 'screening' assessment is presented in **Appendix B** of the **Shadow HRA Report** (**Book 5, Report 5.10**).

1.3.4 **Table 3.1** summarises the European sites and qualifying interest features where it has not been possible to screen out significant effect (from an ornithological perspective only), in light of the potential effect pathways detailed in **Table 2.1**.

**Table 1.2: European sites and relevant qualifying interest features which have potential to be significantly affected by the Sizewell C Project**

| No. | Site name | Qualifying interest features screened in to further assessment[1] |
|---|---|---|
| 1 | Alde-Ore Estuary SPA | Breeding birds:<br>• Avocet *Recurvirostra avosetta*<br>• Marsh harrier *Circus aeruginosus*<br>• Little tern *Sternula albifrons*<br>• Sandwich tern *Thalasseus sandvicensis*<br>• Lesser black-backed gull *Larus fuscus*<br>Over wintering birds:<br>• Avocet *Recurvirostra avosetta*<br>• Redshank *Tringa totanus* |

[1] Qualifying bird interest features only (i.e. any interest feature of a Ramsar site which is not of ornithological interest (e.g. invertebrates, plants) are not included within this table).

| No. | Site name | Qualifying interest features screened in to further assessment[1] |
|---|---|---|
| | | • Ruff *Philomachus pugnax* |
| 2 | Alde-Ore Estuary Ramsar site[2] | • Ramsar criterion 3 - the site supports a notable assemblage of breeding and wintering wetland birds<br>• Ramsar criterion 6 - species/populations occurring at levels of international importance – lesser black-backed gull |
| 3 | Benacre to Easton Bavents SPA | Breeding birds:<br>• Bittern *Botaurus stellaris*<br>• Little tern *Sternula albifrons*<br>• Marsh Harrier *Circus aeruginosus* |
| 4 | Deben Estuary SPA | Over wintering birds:<br>• Avocet, *Recurvirostra avosetta*<br>• Dark-bellied Brent goose *Branta bernicla* |
| 5 | Deben Estuary Ramsar site | • Ramsar criterion 6 - species/populations occurring at levels of international importance - dark-bellied brent goose *Branta bernicla* |
| 6 | Minsmere-Walberswick SPA | Breeding birds:<br>• Avocet *Recurvirostra avosetta*<br>• Bittern *Botaurus stellaris*<br>• Little tern *Sternula albifrons*<br>• Marsh harrier *Circus aeruginosus*<br>• Nightjar *Caprimulgus europaeus*<br>• Shoveler *Anas clypeata*<br>• Teal *Anas crecca*<br>• Gadwall *Anas strepera*<br>Over wintering birds:<br>• Gadwall *Anas strepera*<br>• Hen harrier *Circus cyaneus*<br>• Shoveler *Anas clypeata*<br>• White fronted goose *Anser albifrons albifrons* |
| 7 | Minsmere-Walberswick Ramsar site | • Ramsar criterion 2 – in relation to birds, the site supports an important assemblage of rare breeding birds associated with marshland and reedbeds |
| 8 | Outer Thames Estuary SPA | Breeding birds:<br>• Little tern *Sternula albifrons* |

[2] For all Ramsar sites, the qualifying interest features listed are those which are identified as qualifying 'Ramsar criteria' in the *Information Sheet on Ramsar Wetlands* for each Ramsar site. Other 'noteworthy flora and fauna' are not included as qualifying interest features of the Ramsar site. This approach aligns with that of other recent HRAs for DCO applications (e.g. Wylfa Newydd Nuclear Power Station and East Anglia ONE North Offshore Windfarm).

| No. | Site name | Qualifying interest features screened in to further assessment[1] |
|---|---|---|
| | | • Common tern *Sterna hirundo*<br>Over wintering birds:<br>• Red-throated diver *Gavia stellata* |
| 9 | Sandlings SPA | Breeding birds:<br>• Nightjar *Caprimulgus europaeus*<br>• Woodlark *Lullula arborea* |
| 10 | Stour and Orwell Estuaries SPA | Breeding birds:<br>• Avocet *Recurvirostra avosetta*<br>Over wintering birds:<br>• Pintail *Anas acuta*<br>• Dark-bellied Brent goose<br>• Dunlin *Calidris alpina alpina*<br>• Knot *Calidris canutus*<br>• Black-tailed Godwit *Limosa limosa islandica*<br>• Grey Plover *Pluvialis squatarola*<br>• Redshank *Tringa totanus*<br>• Assemblage qualification: wetland of international importance and waterbird assemblage |
| 11 | Stour and Orwell Estuaries Ramsar site | • Ramsar criterion 5 – assemblages of international importance: waterfowl<br>• Ramsar criterion 6 - species/ populations occurring at levels of international importance |

### b) Receptors relevant to the EIA

1.3.5 As well as the European sites listed above, the Project site is located in close proximity to a number of designated sites of national nature conservation importance for breeding, wintering and passage birds, as well as non-statutory sites of Regional or County importance.

1.3.6 Extensive ornithological survey work has been carried out at the site from 2007 to 2019. **Annex 14A7.5** to **Appendix 14A7** of **ES Volume 2 Chapter 14 (Book 6, Report 6.3)** provides accounts for qualifying species for one or more of the European designated sites within the ZoI of the Project site, and other seabird and waterfowl / wader species recorded during survey work.

1.3.7 **Annex 14A7.6** to **Appendix 14A7 ES Volume 2 Chapter 14 (Book 6, Report 6.3)** provides accounts for species identified on site which are listed on Schedule 1 of the Wildlife and Countryside Act (excluding those already included within **Annex 14A7.5**), as well as accounts for Red and Amber listed species of Birds of Conservation Concern (BoCC) (Ref. 1.1) and/or species listed on Section 41 of the Natural Environment and Rural Communities (NERC) Act. It also includes a list of other species (i.e. Green List species of BoCC) which have been recorded during survey work on site.

1.3.8 All bird species known to have been recorded within the ZoI of the Sizewell C Project have been assessed to determine if they would qualify as IEFs, as defined in Chartered Institute of Ecology and Environmental Management (CIEEM) guidelines on EcIA (Ref. 1.2).

1.3.9 **Table 13.2** lists the receptors which are classified as IEFs and are therefore of relevance for the EIA process (some of which are also relevant in terms of the HRA).

### Table 1.3: Ornithological receptors of relevance to the EIA

| Receptor (IEF) | Criteria determining conservation importance[3] | Importance under CIEEM guidelines/ EIA-specific methodology[4] |
|---|---|---|
| Bittern (breeding and wintering). | SPA/Ramsar, Schedule 1, amber-listed | International/High |
| Avocet (breeding and wintering). | SPA/Ramsar, Schedule 1, amber-listed | International/High |
| Redshank (wintering). | SPA/Ramsar, amber-listed | International/High |
| Shoveler (breeding and wintering). | SPA/Ramsar, amber-listed | International/High |
| Gadwall (breeding and wintering). | SPA/Ramsar, amber-listed | International/High |
| Teal (breeding) | SPA/Ramsar, amber-listed | International/High |
| Teal (wintering) | Amber-listed | Regional/High |
| White-fronted goose (wintering). | SPA/Ramsar, red-listed | International/High |
| Marsh harrier (breeding). | SPA/Ramsar, Schedule 1, amber-listed | International/High |
| Marsh harrier (wintering). | Amber-listed | National/High |

[3] SPA/Ramsar - indicates whether the species/assemblage is a qualifying feature of a SPA or Ramsar site (or is a constituent of a qualifying feature assemblage of a SPA or Ramsar site) within the ZOI of the Sizewell C Project.
Schedule 1 – indicates species is listed on Schedule 1 of the Wildlife and Countryside Act 1981 as amended by the Environmental Protection Act 1990.
Red- or amber-listed – indicates species is of conservation concern at a national level (i.e. is not green-listed) as determined in BoCC.
SSSI – indicates bird assemblage is associated with an SSSI.

[4] As determined in ES Volume 2 Chapter 14.

| **Receptor (IEF)** | **Criteria determining conservation importance**[3] | **Importance under CIEEM guidelines/ EIA-specific methodology**[4] |
|---|---|---|
| Hen harrier (wintering). | SPA/Ramsar, red-listed | International/High |
| Nightjar (breeding). | SPA/Ramsar, amber-listed | International/High |
| Woodlark (breeding and wintering). | SPA/Ramsar, Schedule 1 | International/High |
| Red-throated diver (wintering). | SPA/Ramsar, Schedule 1 | International/High |
| Little tern (breeding). | SPA/Ramsar, Schedule 1, amber-listed | International/High |
| Common tern (breeding). | SPA/Ramsar, amber-listed | International/High |
| Sandwich tern (breeding). | SPA/Ramsar, amber-listed | International/High |
| Kittiwake (breeding). | Red-listed | Regional/High |
| Lesser black-backed gull (breeding). | SPA/Ramsar, amber-listed | International/High |
| Waterbird assemblage qualifying criterion of Alde-Ore Ramsar site (breeding and wintering) and SSSI. | SPA/Ramsar, SSSI | International/High |
| Assemblage of rare marshland and reedbed birds qualifying criterion of Minsmere to Walberswick Ramsar site (breeding)/ assemblage associated with Minsmere to Walberswick Heaths and Marshes SSSI (breeding/wintering). | SPA/Ramsar, SSSI | International/High |
| Bird assemblage associated with Sandlings Forest SSSI and other component SSSI of the Sandlings SPA. | SPA/Ramsar, SSSI | International/High |
| Bird assemblage associated with Sizewell Marshes SSSI. | SSSI | National/High |
| Stone curlew. | Schedule 1, amber-listed | Regional/High |
| Barn owl. | Schedule 1 | Local/Low |
| Kingfisher. | Schedule 1, amber-listed | County/Medium |
| Hobby. | Schedule 1 | County/Medium |
| Peregrine. | Schedule 1 | County/Medium |
| Black redstart. | Schedule 1, red-listed | County/Medium |
| Cetti's warbler. | Schedule 1 | County/Medium |

| Receptor (IEF) | Criteria determining conservation importance[3] | Importance under CIEEM guidelines/ EIA-specific methodology[4] |
|---|---|---|
| Other birds species of nature conservation importance recorded within the site (Grey partridge, Turtle dove, Cuckoo, Marsh tit, Skylark, Starling, Song thrush, Spotted flycatcher, House sparrow, Yellow wagtail, Linnet, Yellowhammer). | | County/Medium |

## 1.4 Summary of evidence

### a) Alteration of coastal processes and sediment transport

1.4.1 Modification of the local wave climate, current dynamics and sediment transport processes by the presence of project infrastructure has the potential to reduce or enhance erosion and/or accretion along the coastline of the affected areas. Significant changes to coastal processes may result in a loss of coastal habitats that support nesting, roosting and foraging activity of marine or coastal bird species (beach, shingle, dunes) and increase the frequency of inundation of low-lying wetland habitats situated behind existing defences, should defence resilience be reduced.

1.4.2 Relevant ornithological IEFs potentially affected by this impact pathway include:

- Breeding populations of qualifying seabird species at Alde-Ore Estuary SPA/Ramsar and SSSI, Benacre to Easton Bavents SPA and Minsmere-Walberswick SPA/Ramsar.
- Non-breeding populations of qualifying waterbird species at Alde-Ore Estuary SPA/Ramsar and SSSI.
- Breeding kittiwake population on the Sizewell Rigs County Wildlife Site (CWS).

#### i. Construction and decommissioning

1.4.3 Baseline information on the hydrodynamics and coastal geomorphology of the greater Sizewell Bay area is provided in BEEMS Technical Report TR311 (Ref. 1.3), which provides data on local wave climate, tidal currents and sediment transport. Historically, the coastline adjacent to Sizewell A and Sizewell B Power Stations has been relatively stable with little change, though there are two areas of persistent erosion north of Sizewell A and Sizewell B, either side of the Minsmere Sluice.

1.4.4 Modelling results indicate that the construction (and decommissioning[5]) of the main development site, including the construction/decommissioning of the discharge outfall, cooling water infrastructure, Fish Recovery and Return (FRR) system, Beach Landing Facility (BLF) and flood and coastal protection measures, would not significantly affect coastal processes. Any impacts on

[5] Using construction as a worst-case proxy for the decommissioning phase

sediment transport would be confined to coastline within 200m of the BLF in each direction, with negligible changes outside this area.

1.4.5 The Alde-Ore Estuary and Benacre to Easton Bavents European sites lie approximately 5km and 15km from the main development site, respectively and therefore beyond the extent to which the potential effect pathway exists. While the Minsmere-Walberswick European site lies within the potential affected area, the nearest little tern colony is located 500 – 700 m north of the Minsmere New Cut, a little over 1.5 km from the main development site at its nearest point and therefore beyond the extent to which the potential effect pathway exists (in terms of effects on nesting habitat).

1.4.6 The limited effects predicted on the coastal processes mean there is little potential for effects to arise on the foraging areas of marine birds, particularly when considered in the context of the extent of the areas over which the relevant species forage (Ref. 1.4, Ref. 1.4, Ref. 1.6).

#### ii. Operation

1.4.7 As per the construction and decommissioning phases, modelling results indicate that the presence of the BLF and other marine and coastal infrastructure during the operational phase would not significantly affect coastal processes. Impacts on sediment transport, even in the event that subsurface elements of the BLF are uncovered, would be confined to within 200m of the BLF. The BLF may trap sediment on both sides and contribute to coastal stability.

1.4.8 As noted above, the nearest little tern colony is located 500 – 700 m north of the Minsmere New Cut, a little over 1.5 km from the main development site at its nearest point and therefore beyond the extent to which the potential effect pathway exists. Other qualifying seabird breeding populations are located at colonies outside the ZoI, whilst there is little potential for effects on the foraging areas of these populations (as noted above).

### b) Water quality effects – marine environment

1.4.9 Changes in marine water quality could potentially affect prey availability for seabird species in the study area. Such changes may be a result of increases in suspended sediment concentration (SSC) during construction and decommissioning activities, namely the installation or removal of marine infrastructure, or the release of thermal or chemical discharges from the cooling water system during the operational phase.

1.4.10 Relevant ornithological IEFs potentially affected by this impact pathway include:

- Breeding populations of qualifying seabird species at Alde-Ore Estuary SPA/Ramsar and SSSI, Benacre to Easton Bavents SPA, Minsmere-Walberswick SPA and Ramsar site and Outer Thames Estuary SPA.
- Non-breeding populations of red-throated diver at Outer Thames Estuary SPA.
- Breeding kittiwake population on the Sizewell Rigs County Wildlife Site (CWS).

i. Construction and decommissioning

1.4.11 Effect pathways exist for increases in SSC and hydrazine (during commissioning), with other sources (e.g. hazardous substances, metals, and biological oxygen demand) predicted to remain within acceptable limits (e.g. as defined by annual load limits or EQS). Increases in SSC may arise as a result of the navigational dredging associated with the BLF and the removal by dredging of overlying soft sediment prior to installation of the CDO head, cooling water system intake and outfall headworks, and FRR outfall headworks. During cold flush testing (at commissioning), discharges of hydrazine may exceed the applied EQS concentrations.

1.4.12 The predicted foraging ranges of the Minsmere-Walberswick SPA and Ramsar site and Alde-Ore Estuary SPA and Ramsar site little tern population (Ref. 1.6) show limited overlap with the instantaneous plumes calculated for surface SSC above 100 mg/l. Although the instantaneous plume varies by dredging activity, the maximum overlap is no greater than 7% of the foraging area. In tidally dominant systems the plume is highly transient so SSC returns to background concentrations within a few days.

1.4.13 The foraging range of other little tern colonies from Outer Thames Estuary SPA, including those breeding at Benacre to Easton Bavents SPA, do not overlap with the SSC plume and are therefore beyond the extent to which the potential effect pathway exists. Other seabird species' foraging areas are not significantly affected; the SSC plume overlaps with less than 1% of each species' foraging area.

1.4.14 Commissioning discharges of hydrazine during commissioning are no greater than those in the operational phase, described in the following section.

### ii. Operation

#### Thermal discharges

1.4.15 The extent of the thermal plume from the cooling water system discharge has been modelled by Cefas using the validated Sizewell GETM, during both the breeding and non-breeding seasons.

1.4.16 In terms of the prey of seabirds in the waters around Sizewell, pelagic species are the most important (notably sprat and herring), particularly in relation to the breeding tern populations. Acoustic surveys of sprat at Sizewell B have shown no apparent avoidance of the existing 2°C uplift chlorinated plume, whilst smelt (a locally common herring-like pelagic species) has shown avoidance at a temperature uplift of 4°C (Ref. 1.7)).

1.4.17 As such, for the purposes of assessing the foraging area that is potentially ‘lost’ to birds foraging in the marine environment as a result of the thermal plume, Cefas advise that it is appropriate to consider the 98$^{th}$ percentile of a 3$^{o}$C temperature uplift as an avoidance threshold (Ref. 1.7) (a 2$^{o}$C uplift is also considered in the **Shadow HRA Report** (**Book 5, Report 5.10**).

1.4.18 Importantly, the waters around Sizewell are already subject to thermal uplift as a consequence of the cooling water system discharges from the existing Sizewell B power station. Therefore, for the purposes of undertaking the assessment of the potential effects of the Sizewell C thermal discharge, it is necessary to also consider and define the thermal plume for Sizewell B, as this represents part of the baseline conditions. The Sizewell B and Sizewell C thermal plumes are predicted to be separate at high uplift temperatures but at lower temperatures (e.g. 2°C and 3°C) the Sizewell C plume acts to increase the size and temperature of the Sizewell B plume at the surface and seabed (Ref. 1.8).

1.4.19 For each of the species or populations on which assessments are required, it is also important to consider the extent of the thermal plumes over the relevant seasonal period (e.g. the different breeding periods for each of the breeding seabird species), as opposed to the full annual period. For breeding seabird species, overlap with the thermal plumes is considered in relation to the extent of the likely foraging ranges, as determined from species-specific data collected across multiple sites and/or studies (e.g. as based upon mean maximum foraging range – Ref. 1.4, Ref. 1.5, Ref. 1.6). For red-throated diver, which are a non-breeding qualifying feature of the Outer Thames Estuary SPA (so that foraging is not constrained by a colony location), overlap with the thermal plumes is considered relative to the area of the Outer Thames Estuary SPA (Ref. 1.7).

1.4.20 Given the above, the assessments undertaken on the effects of the thermal uplift, focus on the plumes for both the 2°C and 3°C uplift thresholds as modelled for the period of relevance for each species or population of interest. These plumes are determined for the mean and maximum instantaneous plume sizes (as calculated at hourly intervals over the relevant seasonal period), as well as the 98$^{th}$ percentile, with the former providing higher resolution information on the spatial distribution (Ref. 1.7).

1.4.21 For the breeding seabird populations which are SPA qualifying features, the spatial overlap between the 2°C and 3°C thermal plumes for Sizewell B together with Sizewell C and the indicative foraging ranges are shown in **Plate 1.1** and **Plate 1.2**. In interpreting these visual outputs, it is important to consider that they illustrate the predicted plume distributions for Sizewell B together with Sizewell C. This means that the plume area associated with Sizewell B is greater than it would be if the effects of Sizewell B alone were modelled. For red-throated diver, the thermal plumes (for the September to March period) encroach onto the north-western block of the Outer Thames Estuary SPA only, which is estimated to hold approximately 20% of the SPA population (Ref. 1.7, Ref. 1.9).

1.4.22 Full details of the extent of the spatial overlap between the thermal plumes and different measures of foraging area for the SPA seabird qualifying features are presented in BEEMS Technical Report TR483 (Ref. 1.7) and the **Shadow HRA Report** (**Book 5, Report 5.10**). For kittiwake breeding at the Sizewell Rigs CWS, the extent of these thermal plumes should be considered within the context of the large breeding season foraging range of this species (i.e. the estimated mean maximum foraging range being 60 km – Ref. 1.4).

**Plate 1.1: The 2°C and 3°C uplifts (as a 98th percentile) for sea surface temperatures for Sizewell B together with Sizewell C for May to August, in relation to the breeding colony locations and predicted foraging ranges for little tern and common tern in the study area**

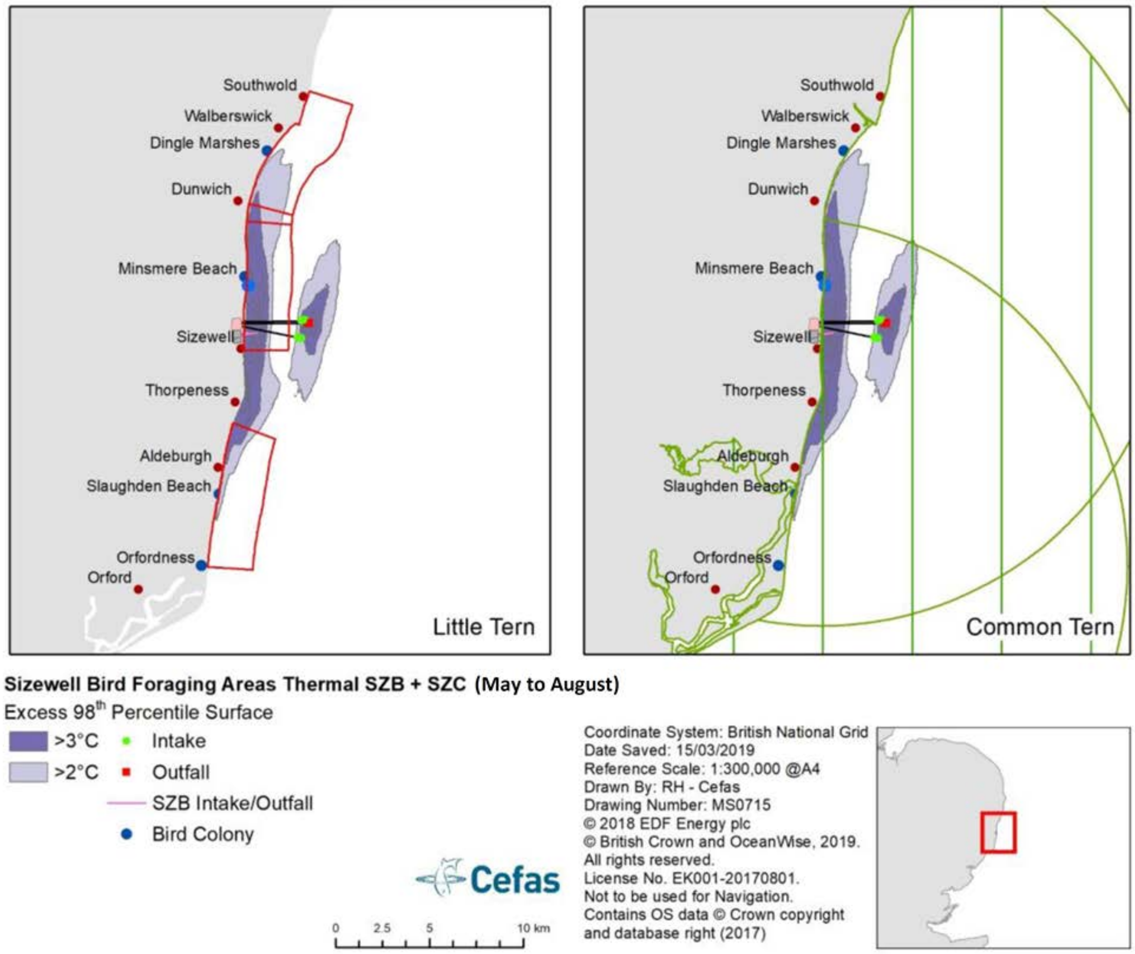
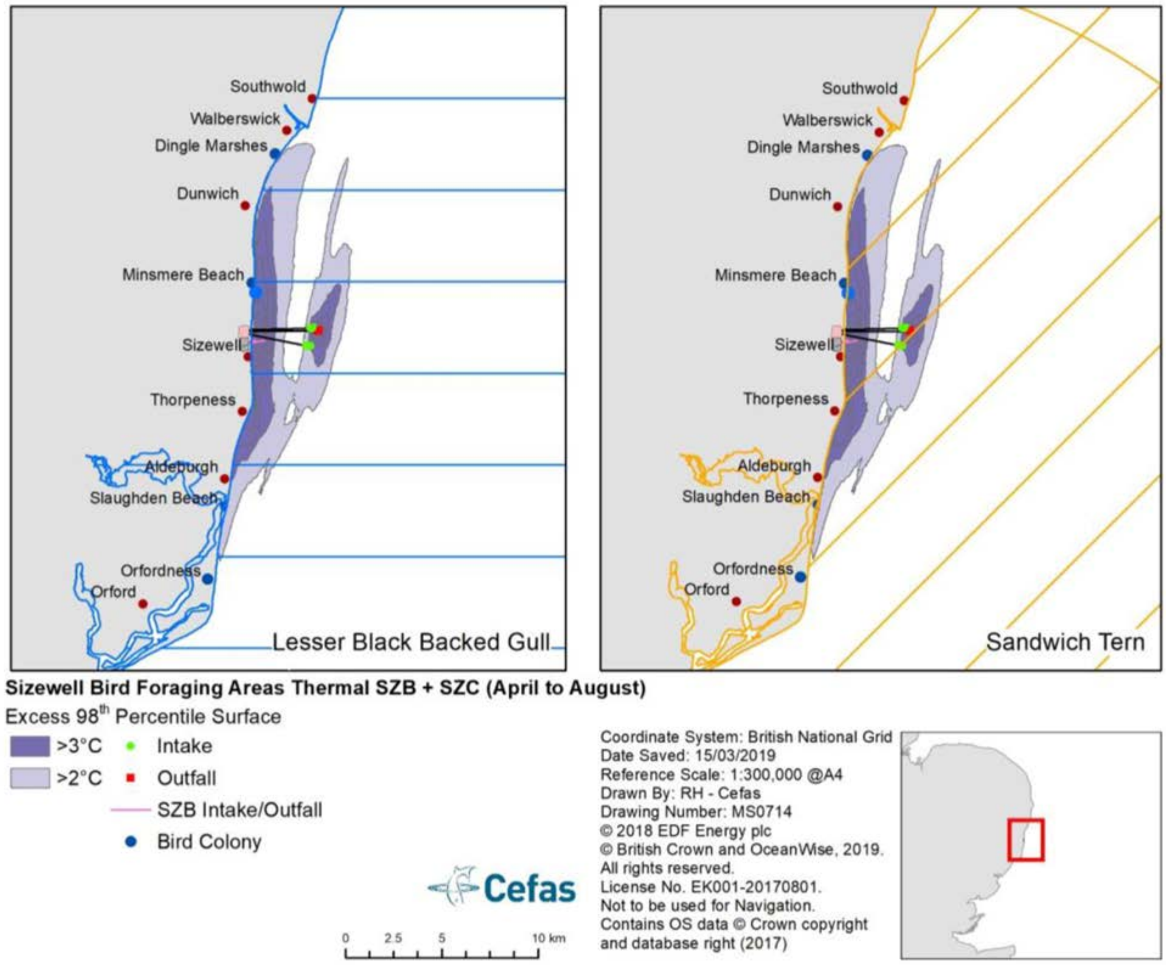


**Plate 1.2: The 2°C and 3°C uplifts (as a 98th percentile) for sea surface temperatures for Sizewell B together with Sizewell C for April to August, in relation to the breeding colony locations and partially shown predicted foraging ranges for lesser black-backed gull and Sandwich tern**




## Chemical discharges

1.4.23 Using the GTEM, discharges of total residual oxidants (TRO), bromoform and hydrazine plumes from the discharge at Sizewell C have also been modelled. Avoidance thresholds for the chemicals are based on PNECs and EQS levels, as described in Ref. 1.7. As for the thermal discharges, the assessment has to consider the effects of the discharges from Sizewell C in the context of the existing discharges from Sizewell B (for those chemicals for which there are discharges from both – i.e. TRO and bromoform).

However, in contrast to the situation for thermal discharges, the chemical plumes resulting from Sizewell B and Sizewell C are spatially distinct at ecologically relevant concentrations (Ref. 1.10).

1.4.24 The TRO, bromoform and hydrazine threshold exceedances associated with the effects of Sizewell C affect smaller areas of the marine environment than the 2°C and 3°C thermal uplifts, with the overlap of the chemical plumes with the indicative foraging ranges of the different SPA breeding seabird populations being below 1% in all cases (**Plate 1.3**, **Plate 1.4** and **Plate 1.5**). These chemical plumes also accounted for 0.1% or less of the SPA area, which is relevant to the assessment of effects on the Outer Thames Estuary SPA non-breeding red-throated diver population.

1.4.25 As for the thermal discharges, full details of the extent of the spatial overlap between the chemical plumes and different measures of foraging area for the SPA seabird qualifying features are presented in BEEMS Technical Report TR483 (Ref. 1.7) and the Shadow HRA Report; **Book 5, Report 5.10**). For kittiwake breeding at the Sizewell Rigs CWS, the extent of these plumes should be considered within the context of the large breeding season foraging range of this species).

**Plate 1.3: TRO concentration at the sea surface (µg/l as a 95th percentile) for Sizewell B and Sizewell C in relation to the breeding colony locations and predicted foraging ranges of breeding seabirds in the study area**

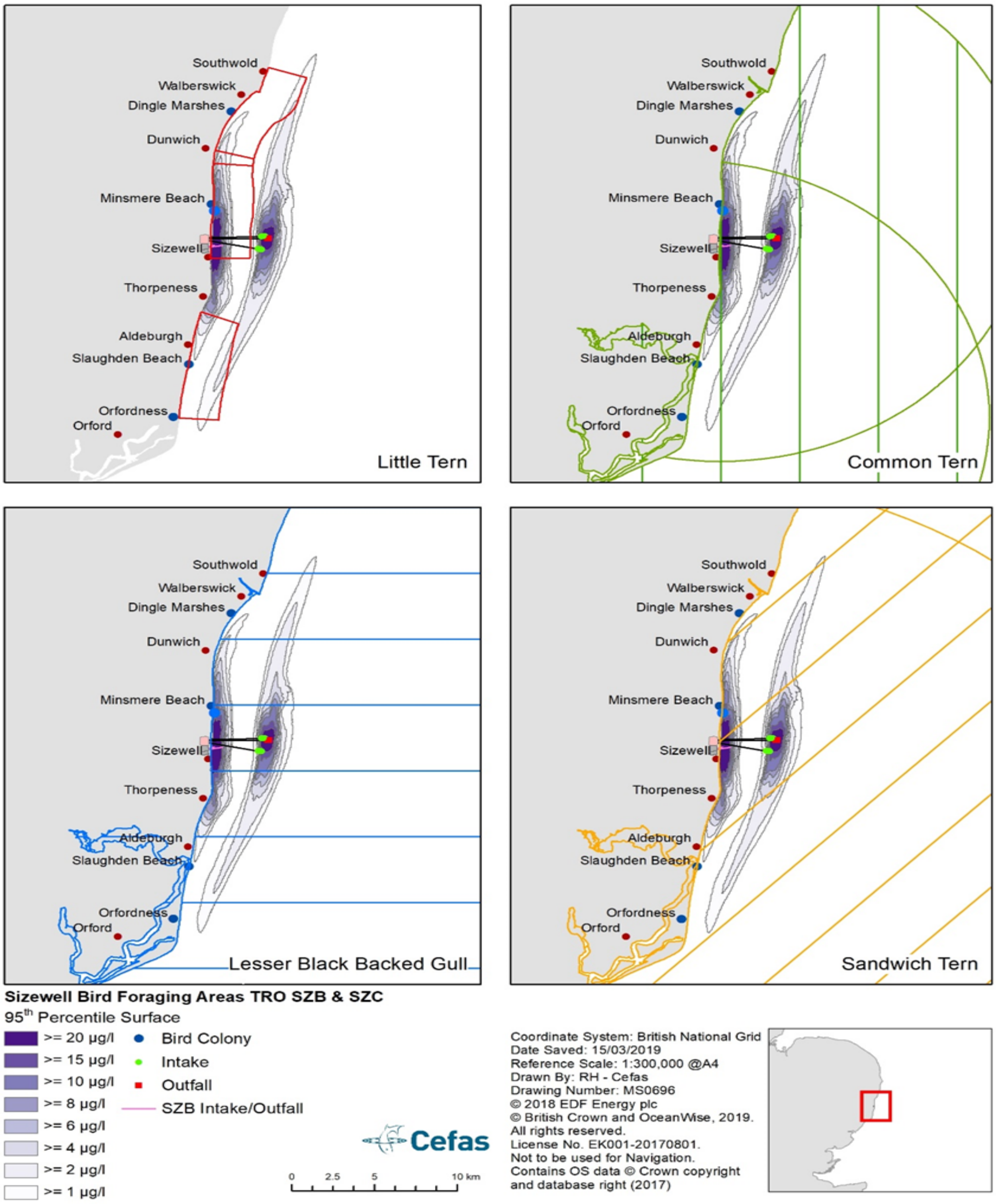


**Plate 1.4: Bromoform concentration at the sea surface (µg/l as a 95th percentile) for Sizewell B and Sizewell C in relation to the breeding colony locations and predicted foraging ranges of breeding seabirds in the study area**

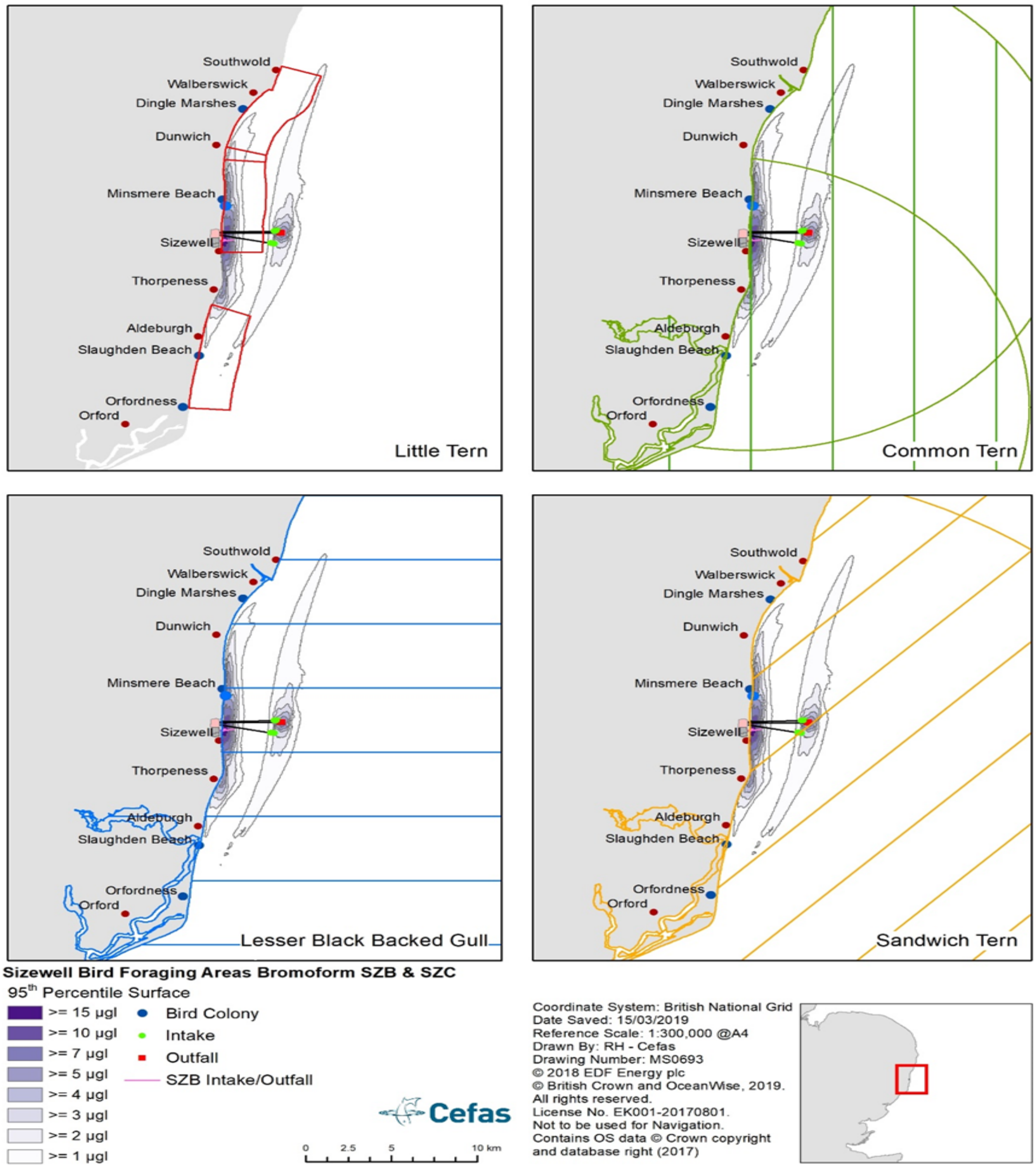
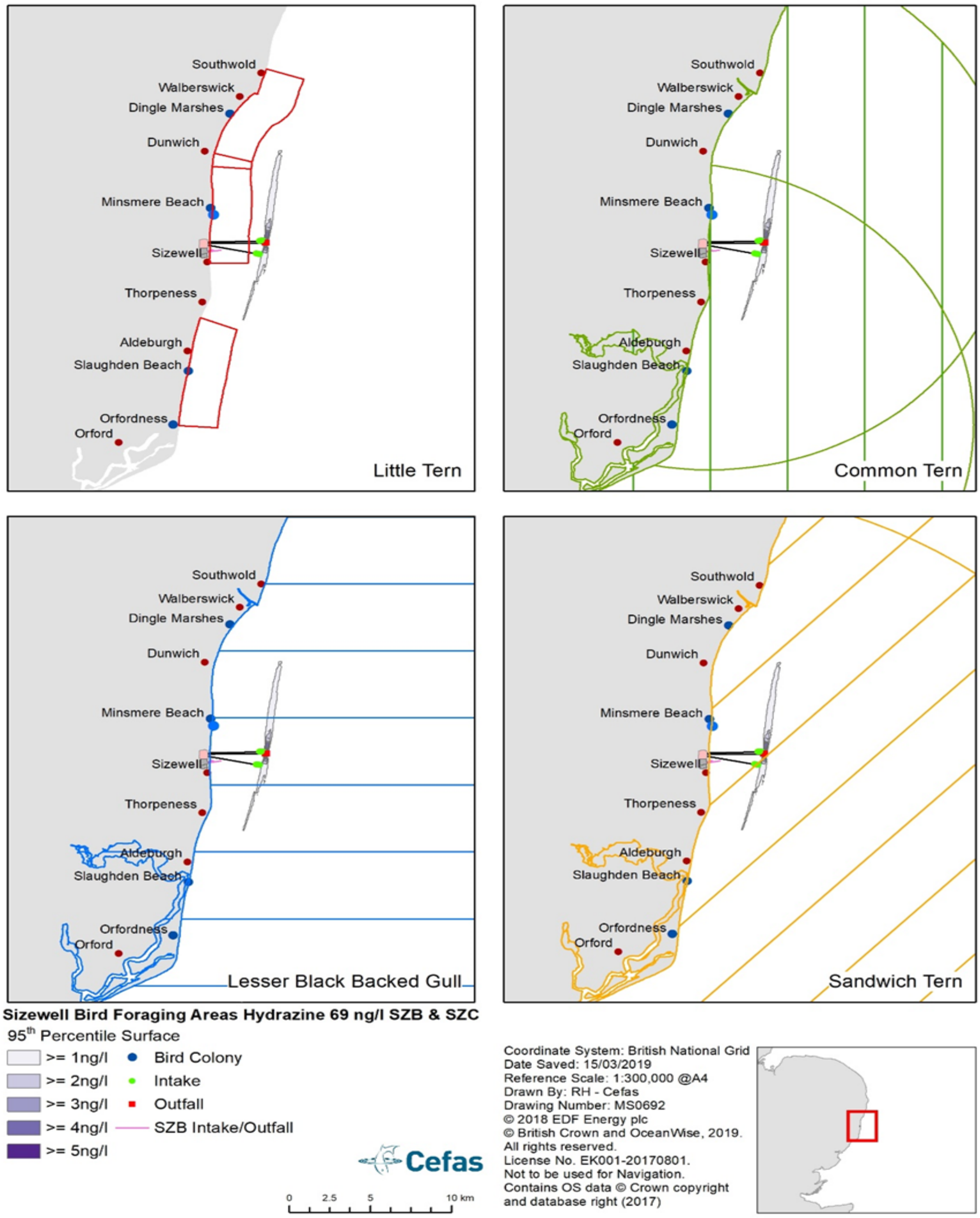


**Plate 1.5: Hydrazine concentration at the sea surface (ng/l as a 95th percentile) after release of 68bg/l from Sizewell C in relation to the breeding colony locations and predicted foraging ranges of breeding seabirds in the study area**



c) Water quality effects – terrestrial environment

1.4.26 Relevant ornithological IEFs bird qualifying features potentially affected by this impact pathway include:

- Breeding populations of marsh harrier, little tern and qualifying waterbird species at Minsmere-Walberswick SPA/Ramsar and Minsmere to Walberswick Heaths and Marshes SSSI;
- Non-breeding populations of hen harrier and qualifying waterbird species at Minsmere-Walberswick SPA and Minsmere to Walberswick Heaths and Marshes SSSI;. and
- Bird assemblage associated with the Sizewell Marshes SSSI.

i. Construction and decommissioning

1.4.27 Mitigation measures are embedded in the design to manage surface water discharges. Infrastructure would be in place to ensure all surface run-off and foul water is captured and treated and will not enter supporting habitats for bird species in Minsmere-Walberswick European site. Any foul water flows would be treated to ensure water quality effects are controlled (as part of the primary/ tertiary mitigation measures).

1.4.28 A Construction Drainage Strategy will include mitigation measures which would manage surface water discharges. Infrastructure to be constructed would include ditches, bunds and swales to prevent surface water runoff from leaving the site, and oil/petrol interceptors would be incorporated into the drainage design. Where complete infiltration to the ground is not feasible, Water Management Zones (WMZs) are included in the design.

1.4.29 The systems described would discharge treated water to the surface-water drainage network, and foul water would be treated prior to discharge to sea, which would prevent the contamination of surface waters with sewage effluent.

1.4.30 Project works would be carried out in line with Sizewell C Project's Code of Construction Practice (CoCP), which would enforce pollution prevention and control measures.

1.4.31 The mitigation measures described will ensure that there are no effects on supporting habitat and therefore bird species would not be affected. The infrastructure will remain in place during the decommissioning phase.

ii. Operation

1.4.32 The Drainage Strategy and associated infrastructure will remain in place throughout the operational phase and therefore there would be no effects on supporting habitats. No chemical effects are predicted during the operational phase in this context (as all discharges would be via the cooling water system).

d) Alteration of local hydrology and hydrogeology

1.4.33 The construction, operation and decommissioning phases may result in changes to hydrological conditions (surface water and groundwater) due to effects on flows and water levels.  Consequently, this may affect the extent of wetland habitats (including marshland, reedbed and open water) that support a number of bird species. In particular, during construction changes in hydrological conditions may result from:

- the diversion of the Sizewell Drain within Sizewell Marshes SSSI;
- installing a reinforced concrete cut-off wall allowing the main platform area to be dewatered;
- installation of sheet piling to protect Sizewell Marshes SSSI;
- infilling the former Sizewell Marshes SSSI land; and
- construction of the SSSI crossing to provide access to the main platform.

1.4.34 Relevant ornithological IEFs potentially affected by this impact pathway include:

- Breeding populations of marsh harrier, little tern and qualifying waterbird species at Minsmere-Walberswick SPA/Ramsar and Minsmere to Walberswick Heaths and Marshes SSSI;
- Non-breeding populations of hen harrier and qualifying waterbird species at Minsmere-Walberswick SPA and Minsmere to Walberswick Heaths and Marshes SSSI; And
- Bird assemblage associated with the Sizewell Marshes SSSI.

i. Construction, operation and decommissioning – Minsmere-Walberswick SPA/Ramsar and Minsmere to Walberswick Heaths and Marshes SSSI

1.4.35 As described in **Section 1.4c)i**, primary mitigation measures are embedded in the project design to manage surface water discharges adequately during the construction phase that could affect the flow regime of the systems. These measures, combined with the proposed Sizewell Drain realignment, largely isolate the proposed development from the surrounding areas. Similar measures would be applied in the decommissioning phase.

1.4.36 Proposed water management structures would also allow for manipulation of the water levels and flows. Therefore, it is anticipated that the construction and decommissioning of the Sizewell C Project would have no significant effects on the flow regime and no effect on the supporting habitats of bird species in Minsmere-Walberswick European site.

1.4.37 Modelling predicts a small and localised drawdown on groundwater affecting an area of 0.6 ha (<0.03% of the SPA area) which would be short-term and reversible. This is in an area of non-wetland habitat not considered sensitive to changes in groundwater level.

ii. Construction operation and decommissioning – Sizewell Marshes SSSI

1.4.38 Results of modelling to assess hydrological change in the Sizewell Marshes SSSI from different construction scenarios are presented in the **Plants and Habitats Synthesis Report (Volume 2, Chapter 14, Appendix 14B1) (Book 6, Report 6.3)**. These indicate that, in the absence of mitigation, dewatering within the cut off wall could cause a drawdown in groundwater levels within Sizewell Marshes SSSI by up to 10cm in both the peat and crag deposits. Note that these drawdown contours represent the worst-case scenario (i.e. the largest modelled drawdown during drought conditions) and it is not envisaged that these conditions would be maintained for the entirety of the construction phase. Drawdown is most likely adjacent to the cut off wall decreasing substantially moving west. The installation of the cut off wall also has the potential to increase groundwater levels as flowpaths will be blocked by an impermeable structure (see **ES Volume 2, Chapter 19; Book 6, Report 6.3**).

1.4.39 The modelling also indicates that primary mitigation (in the form of a control structure such as a pivot sluice on the realigned Sizewell Drain) would be effective in correcting any changes between the synthetic baseline and changes (drawdown) caused by construction scenarios and is likely to maintain the status quo, so preventing any major changes to the underlying hydrological regime. Flow data from an existing control structure on the

Leiston Drain provide confidence that the proposed primary mitigation would be effective (see **ES Volume 2, Chapter 19; Book 6, Report 6.3**).

1.4.40 Modelling undertaken to assess the predicted changes in water levels as a result of constructing the SSSI crossing (culvert and embankment) predicts only a very small, highly localised effect, such that during initial construction there would be a temporary 2cm reduction in water levels to the east of the SSSI crossing and a 1cm reduction to the west. This effect would rapidly diminish over distance, not being apparent beyond a radius of 90m and water levels would return to normal relatively quickly.

1.4.41 The modelling and evidence base outlined above suggests relatively minor effects on habitat. As such effects on the associated bird assemblage are considered unlikely. Modelling work also indicates no significant changes in water chemistry within the Sizewell Marshes SSSI.

#### e) Changes in air quality

1.4.42 Changes in air quality would not have a direct effect upon ornithological IEFs but could cause effects via changes to vegetation (composition and structure) within the supporting habitats upon which the ornithological IEFs depend.

1.4.43 Relevant ornithological IEFs potentially affected by this impact pathway include:

- Qualifying features (breeding and non-breeding) of the Minsmere-Walberswick SPA/Ramsar and Minsmere to Walberswick Heaths and Marshes SSSI;
- Qualifying features (breeding and non-breeding) of the Alde-Ore Estuary SPA/Ramsar and SSSI;
- Qualifying features of the Sandlings SPA and component SSSIs;
- Bird assemblage associated with the Sizewell Marshes SSSI; and
- A wide range of the other ornithological IEFs listed in **Table 3.2** including non-qualifying populations associated with the SPAs/Ramsar sites and SSSIs.

##### i. Construction and decommissioning

1.4.44 A key potential effect of the construction and decommissioning phases on air quality is the generation of dust, whilst construction activities may also generate emissions of oxides of nitrogen ($NO_x$), sulphur dioxide ($SO_2$) and nitrogen and acid deposition (with the former two representing the gaseous elements of the emissions and the latter the small proportion of the gaseous emissions that are precipitated, often in rain). Diesel generators and vehicles are amongst the sources of $NO_x$, $SO_2$ and nitrogen and acid deposition, whilst dust is generated primarily through the following activities:

- Demolition works and on-site crushing and screening of aggregate;
- Earthworks, including soil stripping, stockpiling and excavation;
- On-site concrete batching; and
- The movement of HGVs and other vehicle movements on site.

1.4.45 The Institute of Air Quality Management (Ref. 1.11) states that ecological receptors within 50m of potential dust sources, within 50m of the routes used by construction vehicles on the public highway and within 500m of construction site access may potentially be affected. A dust deposition rate of 0.5 $g/m^2/day$ has been agreed with consultees as the threshold level above which significant ecological effects due to deposited dust are predicted to occur.

1.4.46 The air quality assessment (**ES Volume 2, Chapter 12; Book 6, Report 6.3**) predicts that the extent of any dust-related effect during construction (and decommissioning) is likely to occur over a relatively small area, with deposition likely to occur close (tens of metres) to the point of origin and would therefore only have the potential to affect supporting habitat within or immediately adjacent to the construction site. Dust generation would likely continue for the duration of the construction phase, but the impacts of dust are likely to be reversible.

1.4.47 To mitigate the effects of this pathway, a dust management plan will be developed which will outline a range of measures that would ensure dust generation is kept to a minimum (and within the threshold level).

1.4.48 Therefore, although some of the habitats of importance to ornithological IEFs are considered sensitive to dust deposition (e.g. dry heaths within certain of the SPAs and some of vegetation within the Sizewell Marshes SSSI - **ES Volume 2, Chapter 12; Book 6, Report 6.3**), the localised nature of the deposition combined with the proposed mitigation would limit effects on supporting habitats for the ornithological IEFs.

1.4.49 Construction phase traffic effects have the potential to affect supporting habitats for bird species at the Minsmere-Walberswick and Sandlings European sites, as these are located near to possible transport routes. In the air quality assessment, the transport contribution of nitrogen oxides (NOx) in the 2023, 2028 typical day and 2028 busiest day scenarios increases relative to respective reference cases at both European sites.

1.4.50 Locations where these values are highest are as a result of the European sites being immediately adjacent to roads. In these cases, it is important to acknowledge that this value is only representative of the portion of the European sites immediately adjacent to the roads.

1.4.51 It should be noted that the background levels of nutrient and acid deposition already exceed the Critical Load. Given the background rates of high chronic deposition, there are unlikely to be significant changes in supporting habitat condition.

1.4.52 For other sites of importance for ornithological IEFs (e.g. the Sizewell Marshes SSSI), the modelling undertaken to predict the effects of emissions of $NO_x$, $SO_2$, and nitrogen and acid deposition during construction indicates at most minor and / or short terms effects on the supporting habitats for ornithological IEFs (**Plants and Habitats Synthesis Report (Volume 2, Chapter 14, Appendix 14B1) (Book 6, Report 6.3)**).

### ii. Operation

1.4.53 The assessment of the potential effects on air quality requires assessment of the Process Contribution (PC) (the modelled concentration of substances from the emission sources included in the assessment) in the context of the environmental standards for European sites (as set out in guidance from Defra and Environment Agency (Ref. 1.12)).

1.4.54 For European sites, for emissions to be considered insignificant (i.e. to confirm that no further assessment is needed), the PC must meet both of the following criteria:

- the short-term (daily) PC is less than 10% of the short-term environmental standard; and,
- the long-term (annual) PC is less than 1% of the long-term environmental standard.

1.4.55 If the above requirements are not met, the predicted environmental concentration (PEC) (the PC plus the background concentration of the substance already present in the environment) needs to be compared to the environmental standard. The PEC does not need to be calculated for short-term targets; but if the short-term PC exceeds the screening criteria, further detailed assessment is required.

1.4.56 If the long-term PC is greater than 1% but the PEC is less than 70% of the long-term environmental standard, the emissions are considered to be insignificant and do not need to be assessed further. If the PEC is greater than 70% of the long-term environmental standard, further assessment is required.

1.4.57 For all other nature conservation sites, the assessment needs to determine whether the installation will result in “significant pollution” i.e. where Critical Levels are exceeded. Therefore, if the long- and short-term PC is less than 100% of the relevant standard, it is considered to be not significant

1.4.58 For the qualifying habitats of the Alde, Ore and Butley Estuaries Special Area of Conservation (SAC) and Orfordness to Shingle Street SAC, which underpin the presence of the bird species at the Alde-Ore Estuary SPA/Ramsar, modelling of the combustion scenarios (reported in **ES Volume 2, Chapter 12**) predicts that the PEC would not exceed Critical Levels for NOx (annual average), NOx (daily average) and $SO_2$ (annual average) (based on site-specific Critical Levels for European sites from the Air Pollution Information System (APIS)). Similarly, the Critical Load for nutrient nitrogen deposition would not be exceeded.

1.4.59 The modelling of combustion scenarios indicated that the average daily NOx PC at Sandlings SPA would exceed 10% of the short-term environmental standard. However, the PEC is predicted to be 40% of the Critical Level (i.e. the Critical Level would not be exceeded) and therefore considered to be insignificant in the context of guidance from Defra and the Environment Agency (Ref. 1.12).

1.4.60 For the qualifying habitats of Minsmere to Walberswick Heath SAC, which underpin the presence of bird species at Minsmere-Walberswick SPA/Ramsar, modelling of the combustion scenarios suggests an exceedance of Critical Levels from average daily NOx PC. However, modelling results significantly over-estimate the predicted exceedance as the model assumes constant operation of a diesel generator, when in reality generators would operate for 8.2% of the year, and the zone of influence is limited to a small area at the southern end of the SAC. More importantly, the annual mean NOx PEC is below the Critical Level, and long-term effects are more significant than short-term effects (Ref. 1.13).

1.4.61 The situation in relation to the predicted $NO_x$ emissions for Sizewell Marshes SSSI is as described above for the Minsmere to Walberswick Heath SAC, with the habitats at the Sizewell Marshes expected to have time to recover from any short-term exposure to elevated levels. No exceedances of the Critical Level for $SO_2$ emissions are predicted at the Sizewell Marshes SSSI, whilst the small increases in nitrogen and acid deposition would have little effect on the vegetation of this site (**Plants and Habitats Synthesis Report (Volume 2, Chapter 14, Appendix 14B1) (Book 6, Report 6.3)**).

f) Direct habitat loss and fragmentation

1.4.62 Relevant ornithological IEFs potentially affected by this impact pathway include:

- Breeding populations of marsh harrier and nightjar at Minsmere-Walberswick SPA/Ramsar and Minsmere to Walberswick Heaths and Marshes SSSI, and of nightjar and woodlark at Sandlings SPA;
- Non-breeding populations of gadwall, shoveler and hen harrier at Minsmere-Walberswick SPA;
- Bird assemblage associated with the Sizewell Marshes SSSI; and
- Other species identified in **Table 3.2** which use habitats within the main development site (e.g. conifer plantations, semi-natural broad-leaved woodland and acid grassland).

i. Construction, operation and decommissioning

1.4.63 The construction works at the main development site would lead to the loss of a relatively small area of the Sizewell Marshes SSSI to accommodate the SSSI crossing and the western part of the main platform. The area affected represents a small proportion of the coastal grazing marsh and reedbed habitats within the Sizewell Marshes SSSI, but a much smaller proportion of the total area of wetland foraging habitat available for species such as marsh harrier and hen harrier.

1.4.64 Potential effects of this habitat loss within the SSSI on the Minsmere-Walberswick SPA populations of breeding marsh harrier and non-breeding gadwall and shoveler could arise due to functional linkage, with the Sizewell Marshes providing potential supporting habitat for these SPA qualifying features (e.g. via the provision for foraging habitat).

1.4.65 Baseline data show that numbers of non-breeding gadwall and shoveler using the Sizewell Marshes vary within and between years but overall are low compared to those occurring in other areas of suitable habitat within, and in close proximity to, Minsmere-Walberswick SPA (see **Shadow HRA Report, Section 6.3f, Book 5, Report 5.10**). Distribution data suggest that the areas of habitat which would be lost are not of disproportionate importance to these SPA qualifying features when compared to unaffected wetland areas. Baseline surveys recorded relatively little activity by hen harriers within the vicinity of the main development site, including Sizewell Marshes (see **Shadow HRA Report, Section 6.3 f, Book 5, Report 5.10**), and the intensity of usage by foraging marsh harriers in Sizewell Marshes is less than in areas of wetland nearer to the main nesting areas, which are within the Minsmere-Walberswick SPA (**Shadow HRA Report, Section 6.3 f, Book 5, Report 5.10**).

1.4.66 In addition to providing potential supporting habitat to SPA qualifying features, the Sizewell Marshes SSSI also supports a wide range of other breeding and wintering bird species (**Appendix 14A7** to **ES Volume 2 Chapter 14; Book 6, Report 6.3**). To mitigate for the loss of habitat within Sizewell Marshes SSSI (and provide alternative wetland habitat for bird species), primary mitigation measures to create like-for-like replacement reedbed and ditch habitat have been implemented at Aldhurst Farm, with habitats establishing and developing successfully. There has been recorded use of the created habitat already by gadwall and shoveler and attempted breeding by a pair of marsh harriers in 2019. The new reedbed and ditch habitats at Aldhurst Farm are located adjacent to the western edge of the Sizewell Marshes SSSI, so are contiguous with existing wetland habitat used by foraging marsh harriers, hen harriers and other bird species.

1.4.67 Baseline surveys (see **Shadow HRA Report, Section 6.3 f, Book 5, Report 5.10**) provided no evidence of breeding nightjars or woodlarks within or close to the areas encompassed by the main development site. It is also unlikely that nightjars and woodlarks from the Minsmere-Walberswick and Sandlings SPAs will rely on suitable habitat near to the main development site for foraging because the main breeding sites for these species within these SPAs are over 1 km from the main development site. Although nightjar have been recorded foraging at distances of up to 3.1 km from their nests, most foraging is generally much closer to the nest and studies of radio-tracked birds in southeast England recorded a mean maximum distance of 747 m from the territory centres (Ref. 1.14).

1.4.68 A range of other ornithological IEFs use habitat within the main development site and may be affected by direct habitat loss and fragmentation. These include barn owl, hobby, black redstart and Cetti's warbler, with details of the abundance and habitat use of these species within the main development site provided in **Appendix 14A7** to **ES Volume 2 Chapter 14; Book 6, Report 6.3**.

### g) Disturbance effects on species populations

#### i. Disturbance in the terrestrial environment

#### Introduction

1.4.69 Anthropogenic disturbance may affect birds by temporarily or permanently displacing them from a disturbed area, resulting effectively in habitat 'loss'. Depending on the importance of the affected area to a species, this may affect the local population size, for example if birds are displaced regularly or permanently from formerly preferred feeding/nesting areas. Disturbance may affect energy budgets – meaning that birds need to spend more time feeding to meet their energy needs (and during breeding the energy requirements of dependent offspring); and cause physiological stress. Disturbed birds may face an increased predation risk and displacing breeding adults from nests can increase the risk of breeding failure. Noise disturbance may interfere with auditory communication between birds.

1.4.70 Relevant ornithological IEFs potentially affected by this impact pathway include:

- Qualifying features (breeding and non-breeding) of the Minsmere-Walberswick SPA and Ramsar site and Minsmere to Walberswick Heaths and Marshes SSSI;
- Qualifying features of the Sandlings SPA and component SSSIs;
- Qualifying features of the Deben Estuary SPA and Ramsar site;
- Qualifying features of the Stour and Orwell Estuaries SPA;
- Bird assemblage associated with the Sizewell Marshes SSSI; and
- A wide range of the other ornithological IEFs listed in **Table 3.2** including non-qualifying populations associated with the SPAs and Ramsar sites and SSSIs identified above, and ornithological IEFs reliant on non-designated habitats within and in close proximity to the main development site.

1.4.71 For the above ornithological IEFs, the main development site represents the potential source of noise and visual disturbance in all cases, except for the Deben Estuary SPA and Ramsar site and the Stour and Orwell Estuaries SPA, for which the Freight Management Facility is the potential source of this effect.

1.4.72 Disturbance effects on bird populations may arise via visual and acoustic stimuli associated with the construction, operation and/or decommissioning of the Sizewell C Project. A noise and visual disturbance evidence base that supports the assessment of potential impacts on the above IEFs is presented in **Appendix 2** (for breeding and non-breeding birds, with the exception of marsh harrier) and **Appendix C** for marsh harrier.

### Construction and decommissioning (breeding and non-breeding birds, excluding marsh harrier)

#### *Modelling of daytime construction noise*

#### Predictions for the different construction phases

1.4.73 Modelling has been undertaken to determine the daytime noise levels that could arise during the construction period for the Sizewell C Project. For the purposes of this exercise, peak noise levels ($L_{Amax}$) have been determined. Peak levels are the highest levels which might occur for a fraction of second during the noisiest component of an activity. In most instances for construction noise the $L_{Amax}$ value represents sudden impulsive or impact sounds such as hammering. As outlined above, such impulsive / impact sounds are those most likely to cause behavioural responses (e.g. startling, flight) in birds and other wildlife. For this reason, it has been selected as the best single parameter to model in this case.

1.4.74 Noise levels can also be characterised by a parameter which represents the typical overall level from a group of activities around the site (for which the $L_{Aeq}$ is used). To predict this level, typical noise levels from each type of activity are considered along with the total number of activities of each type; the locations in which they might occur and the durations over which they might operate within a given assessment period (which is typically a busy working day).

1.4.75 Noise modelling to predict $L_{Amax}$ values was undertaken separately for each of the five construction phases, based upon the current understanding of the predicted worst-case scenario across the entirety of each phase. These noise modelling outputs are summarised in a series of figures as described below.

1.4.76 **Figure 14B2.1** shows the peak noise levels that could arise during Phase 1 construction with mitigation in the form of a 5m high fence along much of the north-eastern boundary of the main development site in place to provide greater attenuation of noise out from the site.. It is assumed that such a fence (or equivalent mitigation) will be in place and, therefore, the assessment is undertaken in relation to this mitigated scenario. Phase 1 construction may extend to the first 2.5 years of the construction programme and will involve activities such as the stripping of soils from borrow pit areas, overburden excavation from borrow pits, crag removal and topsoil stripping on, and overburden excavation from, water management zones.

1.4.77 **Figure 14B2.2** shows the peak noise levels that could arise during Phase 2 construction (with the 5m high fence or equivalent mitigation in place). Phase 2 is expected to extend over a period of 1.5 to 3.5 years, which may have a small overlap with Phase 1. Work during Phase 2 will include backfilling with excavators and stockpiling using bulldozers.

1.4.78 **Figure 14B2.3** shows the peak noise levels that could arise during Phases 3 and 4 of construction (with the 5m high fence or equivalent mitigation in place). Phases 3 and 4 are expected to extend over a period of 7 to 8 years, continuing until approximately year 10 (when final restoration works begin – Phase 5). During Phases 3 and 4, no earthwork movements are anticipated to occur, although inspection and maintenance may be necessary on occasions.

1.4.79 **Figure 14B2.4** shows the peak noise levels that could arise during Phase 5 construction (with the 5m high fence or equivalent mitigation in place). Phase 5 is expected to extend over approximately 6 months and will involve restoration works, such as the removal of stockpiles. During Phase 5 there may also be potential to apply further mitigation to reduce noise emissions from some parts of the main development site.

1.4.80 For each construction phase described above, the modelling outputs show the predicted worst-case from the entire duration of that phase, as determined from the activities occurring at some point during the full duration of this phase (but which, in reality, would not necessarily occur simultaneously). This means that the noise emissions predicted for each phase are likely to be overestimates (and hence precautionary), whilst the duration of the worst-case scenario would not extend over the entire phase. Therefore, when interpreting the noise modelling outputs in **Figure 14B2.1** to **Figure 14B2.4**, it is important to consider the precautionary approach to the modelling, which is likely to result in overestimation of the peak noise levels and their duration for each of the construction phases.

### Construction works associated with the water storage area

1.4.81 The construction works associated with the proposed water storage area in the north-east of the main development site would be limited to the first winter of the construction period. As such, noise disturbance from these works would not coincide with the seasonal period relevant to the breeding qualifying features of the Minsmere-Walberswick SPA and Ramsar site and Minsmere to Walberswick Heaths and Marshes SSSI, but would coincide with the non-breeding season and, therefore, these works do have the potential to affect the non-breeding qualifying features of the SPA, Ramsar site and SSSI. Predicted noise levels from the construction works associated with the water storage area are not included in **Figures 14B2.1** to **14B2.4**, but modelling was for these works was undertaken on the assumption that excavators would be required in the site compound area, the water storage area and to south of this where pipes would be laid and a new wetland corridor created, immediately west of the Grove. Based upon the resulting predictions, the 70 dB $L_{Amax}$ contour extends a little more than 200 m out from the northern and eastern boundaries of the site boundary in this location.

### Extent of predicted noise disturbance effects

1.4.82 As outlined in **Appendix 2** (to this document), a likely noise level threshold at which a potentially adverse behavioural response could be initiated for wintering waterbirds is taken as 70dB $L_{Amax}$, with a value of 65 dB $L_{Amax}$ assumed for breeding waterbirds (but with the assessment based upon the slightly more precautionary 64 dB $L_{Amax}$ threshold, in line with the outputs from the noise modelling). These thresholds are based on observational and experimental work in respect of impulsive noise and the response of waterbirds to these noise sources and levels. However, it should be noted that the conclusions reached from the work on impulsive noise levels relate to the behavioural responses of birds already present within the area exposed to the increased noise levels and not birds moving into an area already subject to such noise levels, as would apply at Sizewell.

1.4.83 The noise modelling outputs demonstrate that, under the worst-case scenario which is assumed, noise levels of 70 or 64 dB $L_{Amax}$ or above encroach onto a small part of the Minsmere-Walberswick SPA and Ramsar site and the Minsmere to Walberswick Heaths and Marshes SSSI only, with this encroachment limited to the south-eastern extremity of the SPA, but with the SSSI experiencing this predicted noise level over a larger area than the SPA due to the fact that the SSSI extends beyond the SPA boundary in the area of predicted elevated noise level (**Figures 14B2.1** to **14B2.4**). The extent to which the SPA and SSSI is affected by this encroachment is greatest during Phase 1 of the construction period, with similar areas affected during Phase 2 and considerably smaller areas affected in Phases 3 to 5. Construction noise levels across the vast majority of the SPA and SSSI, including the main reedbed and open water habitats within the RSPB reserve (which provides the key breeding sites for several of the relevant ornithological IEFs), are predicted to be close to, or below, 54 dB $L_{Amax}$. Similarly, predicted noise levels remain close to, or below, 54 dB $L_{Amax}$ throughout the Sandlings SPA.

1.4.84 The Minsmere South Levels and Sizewell Marshes SSSI also provide suitable habitat for waterbirds. Encroachment of the 70dB $L_{Amax}$ footprint onto the Minsmere South Levels is also minimal during all construction phases (and restricted to the southern extremities of the area), but a substantial part of the Sizewell Marshes SSSI is predicted to occur within this footprint during Phases 1 and 2, with this reducing substantially during Phases 3 to 5 (**Figures 14B2.1** to **14B2.4**). Encroachment of the 64 dB $L_{Amax}$ footprint onto both areas is substantive during Phases 1 and 2, with this footprint encompassing the vast majority of the Sizewell Marshes SSSI during these phases (**Figure 14B2.1** and **14B2.2**). A large part of the Sizewell Marshes SSSI continues to be encompassed by the 64dB $L_{Amax}$ contour during Phases 3 and 4, but by Phase 5 there is little encroachment (**Figure 14B2.3** and **14B2.4**).

*Night-time noise levels*

1.4.85 Construction activities between 2300 and 0700 hours would be considerably reduced compared to the day-time activities. As such, night-time noise levels would be considerably lower. Activities occurring during the defined night-time period would include rail freight arrivals, unloading and transportation, pre-placement of materials, repositioning of scaffolding, essential plant maintenance, unloading of marine deliveries, dewatering operations and (during Phase 3) tunnelling and excavation activities Therefore, night-time construction activities are not predicted to affect the breeding and non-breeding populations of the Minsmere-Walberswick SPA and Ramsar site, Minsmere to Walberswick Heaths and Marshes SSSI and Sizewell Marshes SSSI.

*Extent of predicted visual disturbance effects*

1.4.86 Activities that could cause visual disturbance would be confined to the main development site but would have the potential to cause effects on adjacent and nearby areas that are used by waterbird populations of the Minsmere-Walberswick SPA and Ramsar site, Minsmere to Walberswick Heaths and Marshes SSSI and Sizewell Marshes SSSI, non-qualifying populations associated with these sites, and ornithological IEFs reliant on non-designated habitats within and in close proximity to the main development site. As described in **Appendix 2** (to this document), based on the evidence of disturbance distances for breeding and wintering waterbirds, it is assumed that such effects could extend as far as 300m from the boundary of the main development site, although this distance would be less where visibility of the construction activities is sufficiently obscured.

1.4.87 A significant portion of the main development site is contained within the coniferous plantation of Dunwich Forest (inclusive of Kenton Hills and Goose Hill), which extends beyond the boundary of the main development site and into the adjacent land, particularly in proximity of the Minsmere South Levels and Sizewell Marshes (**Figure 14B2.6**). Within the main development site, woodland will be retained along the northern border of the Kenton Hills section of Dunwich Forest (abutting Sizewell Marshes), as well as within a substantive part of the Goose Hill section of Dunwich Forest in the north-eastern part of the main development site (Ref. 1.15). Furthermore, much of the land within and around the Sizewell Marshes comprises small fields with relatively heavily wooded boundaries, interspersed by small areas of woodland and scrub (**Figure 14B2.6**). These features (in conjunction with the Kenton Hills woodland) act to obscure visibility of the main development site from large parts of the Sizewell Marshes.

1.4.88 Given the above, a variable potential visual impact zone is applied around the main development site for the purposes of assessing the extent of the surrounding area that may be subject to visual disturbance effects. This is based on using a default distance of 300m which is reduced to 150m where woodland or other habitat features are considered to provide sufficient cover to mean that little, if any, of the construction activities will be visible. In such cases it is possible that high structures (e.g. cranes) may remain visible on the skyline but other activities (e.g. movement of vehicles and people) would be concealed. The full extent of the potential visual impact zone is shown in **Figure 14B2.6**, with the main areas where the reduced distance is applied being:

- The section of the main development site boundary bordered by the Kenton Hill woodland.
- The north side of the electricity supply cable corridor, east of ‘The Studio’.
- The sections along the northern boundary of the main development site which are bordered by Ash Wood, Great Mount Wood and woodland at

Goose Hill, as well as a small part of the section of boundary within which the woodland at Goose Hill is retained within the main development site.

1.4.89 As for noise disturbance, the effects from visual disturbance are considered to have the potential to extend across a small part of the Minsmere-Walberswick SPA and Ramsar site only, being limited to the south-eastern extremity of the SPA (**Figure 14B2.6**) (this is also the case for the Minsmere South Levels). A slightly greater area of the Minsmere to Walberswick Heaths and Marshes SSSI is within the zone where effects from visual disturbance may occur. There is potential for visual disturbance effects to extend across a more substantial part of the Sizewell Marshes SSSI, again as for noise disturbance (**Figure 14B2.6**). In relation to the Sandlings SPA, visual disturbance effects are considered to have the potential to extend onto the north-west extremity of the site only (**Figure 14B2.6**).

1.4.90 Given that the construction works associated with the water storage area in the north-east of the main development site would be limited to the first winter of the construction period, no visual disturbance effects from these works are predicted on the breeding qualifying features of the Minsmere-Walberswick SPA and Ramsar site and Minsmere to Walberswick Heaths and Marshes SSSI, but would coincide with the non-breeding season and, therefore, these works do have the potential to affect the non-breeding qualifying features of the SPA, Ramsar site and SSSI (**Figure 14B2.6**).

### Construction and decommissioning (marsh harrier)

#### *Modelling of daytime construction noise*

##### Predictions for the different construction phases

1.4.91 The noise modelling undertaken for the different construction phases is described in **Section 4.7 ii** (of this document), with the outputs (in terms of the $L_{Amax}$ contours) presented in **Figure 14B2.1** to **Figure 14B2.4**. As detailed in **Section 4.7 ii** (of this document), noise disturbance from the construction works associated with the water storage area in the north-east of the main development site is not considered to affect the assessment for the SPA breeding marsh harrier population because these works would be limited to the first winter of the construction period only.

##### Extent of predicted noise disturbance effects

1.4.92 As described in **Appendix C** (to this document), there is no empirical evidence that provides a robust indication of the sensitivity of marsh harriers or their likely behavioural response to anthropogenic noise. Information and evidence from studies on the responses of ‘birds’, as a group, has therefore largely been used to determine the potential response.

1.4.93 Based on the assumption that foraging marsh harriers may be sensitive to increased noise levels, the species may adopt a range of behavioural responses from no avoidance to complete avoidance which encompasses partial avoidance (i.e. a reduction in foraging activity). The type of reaction exhibited is also likely to vary in relation to the noise level, with avoidance assumed to be more likely at higher noise levels.

1.4.94 A likely noise level threshold at which a potentially adverse behavioural response could be initiated by foraging marsh harrier is taken as 70dB $L_{Amax}$. This threshold is based on observational and experimental work (see **Appendix C**) (to this document) in respect of impulsive noise and the response of wintering waterbirds to these noise sources and levels, and is supported by the observational evidence on foraging marsh harriers at Trimley Marshes (**Appendix C**) (to this document).

1.4.95 As shown on the noise modelling plots, $L_{Amax}$ noise levels within the reedbed habitat at Minsmere used as a breeding site would be below 55 dB and, therefore, substantially below $L_{Amax}$ noise levels recorded from the limited monitoring undertaken within the reedbed and generally below the noise levels recorded from other areas in the vicinity of the main development site at which noise monitoring has been undertaken (**Appendix C**) (to this document). Given the relatively low noise levels predicted at the breeding sites, no disturbance effect on birds within the reedbed habitat used for nesting is predicted.

1.4.96 As detailed in **Section 4.7 ii**, a 5m high fence (or mitigation producing similar effects) will be constructed to ensure attenuation of noise extending to the north-east of the main development site and will be in place prior to the main site clearance associated with the Phase 1 works, so reducing noise levels on the marsh harrier habitat improvement area and the Minsmere South Levels (**Figure 14B2.1**). Therefore, the worst-case scenario for the entire period of Phase 1 construction (which may extend up to the first 2.5 years of the construction period) that has been used to inform the current assessment is as presented in **Figure 14B2.1**. Based on this worst-case for Phase 1, noise levels of 85 dB $L_{Amax}$ are predicted to arise within the majority of the main development site, with the predicted levels declining rapidly to reach 70 dB $L_{Amax}$ approximately 100-500 m into areas surrounding the main development site boundary. The distance at which the threshold level of 70 dB $L_{Amax}$ is reached from the main development site boundary depends largely on the noise source itself, incorporated mitigation measures, location within the site and existing screening. The Phase 1 plot of noise levels shows that the 70 dB $L_{Amax}$ threshold will be exceeded over the southernmost part of Minsmere South Levels, the eastern side and southern end of Sizewell Marshes and at the western edge of the marsh harrier habitat improvement area (**Figure 14B2.1**).

1.4.97 However, as detailed above, **Figure 14B2.1** illustrates the worst-case over the full extent of the Phase 1 period, and modelling across narrower time periods reveals that noise levels are predicted to be considerably lower during much of this period. Specifically, in relation to the marsh harrier habitat improvement area, at no single point in time is it predicted that noise levels of 70 dB $L_{Amax}$ (or above) would extend across the full area of the encroachment indicated in **Figure 14B2.1** (encompassing 8.5 ha of the 48.7 ha habitat improvement area), and any encroachment onto the habitat improvement area (beyond the 0.3 ha area in the south-west corner of the habitat improvement area) is predicted to occur for a total of 24 weeks during the entire Phase 1 period. The maximum area of encroachment of noise of 70 dB $L_{Amax}$ (or above) onto the habitat improvement area during any one week within the Phase 1 period is predicted to be 4.7 ha, with encroachment of an area in excess of 2.4 ha (equivalent to 5% of the habitat improvement area) predicted to occur for a total of seven different weeks over the duration of Phase 1.

1.4.98 Based on the worst-case for Phase 2 construction (which would extend over a period of 1.5 to 3.5 years, possibly overlapping with Phase 1), predicted noise levels remain above 85 dB $L_{Amax}$ within the majority of the main construction site. The worst-case Phase 2 plot shows that the 70 dB $L_{Amax}$ threshold would be exceeded across part of the south-western edge of the habitat improvement area (comprising 2.1 ha), as well as across a similar part of the Minsmere South Levels as the worst-case for Phase 1 (**Figure 14B2.2**). The area at the eastern side of the Sizewell Marshes SSSI across which this noise threshold is exceeded is also similar to that for the worst-case for Phase 1.

1.4.99 For Phase 2, encroachment of noise of 70 dB $L_{Amax}$ (or above) onto the habitat improvement area (other than the 0.3 ha area in the far southwest corner of the habitat improvement area) is expected to occur during two months of this phase. The predicted maximum encroachment of noise of 70 dB $L_{Amax}$ (or above) onto the habitat improvement area (i.e. 2.1 ha) is expected to occur during a single month only, with an estimated area of 1.5 ha predicted to be affected during the second month of encroachment.

1.4.100 During Phases 3 and 4 of construction (which are planned to extend over a period of seven to eight years, through to year 10), the predicted worst-case footprint of noise levels >70 dB $L_{Amax}$ would be considerably reduced compared to those for Phases 1 and 2, with no predicted encroachment onto the habitat improvement area and substantially reduced encroachment onto the Sizewell Marshes SSSI (**Figure 14B2.3**).

1.4.101 During Phase 5 construction (expected to extend over approximately six months), the worst-case predicted noise levels in and around the northern part of the main development site would be higher than in Phases 3 and 4 but would remain lower than those in Phases 1 and 2, and would remain low (and below 70 dB $L_{Amax}$) across the majority of the Sizewell Marshes SSSI. Based upon the predicted worst-case for Phase 5, the 70 dB $L_{Amax}$ would be exceeded across an area of 4.4 ha on the west of the habitat improvement area (**Figure 14B2.4**), but modelling at narrower temporal resolutions reveals that encroachment into the habitat improvement area would occur during two months of this phase only. Furthermore, during Phase 5 there is potential for additional mitigation to be applied (e.g. use of Heston Bale barriers along part of the eastern boundary), which would reduce the extent to which the 70 dB $L_{Amax}$ is exceeded on the habitat improvement area. While uncertainty remains over the behavioural response of marsh harrier, particularly in flight, to increased noise levels, on the basis of the available evidence (**Appendix C**) (to this document), 70 dB $L_{Amax}$ has been taken as a precautionary threshold at which displacement of marsh harrier could initiate from areas in which noise levels above this threshold are predicted to occur. Based on the mapped $L_{Amax}$ contours this would entail potential displacement from habitat that may be used for foraging in and around the main development site, including parts of the Sizewell Marshes, southern parts of the Minsmere South Levels and land to the south and west of the Minsmere South Levels.

1.4.102 Under the worst-case predictions for Phases 1 and 2, parts of the Sizewell Marshes SSSI will be subject to an increase in noise levels greater than 70 dB $L_{Amax}$ and, therefore, potentially lost to marsh harrier for foraging (**Figure 14B2.1** and **Figure 14B2.2**). As detailed above, these are worst-case predictions and such noise levels are only expected to occur for a proportion of the time period encompassed by construction Phases 1 and 2 (as demonstrated by the modelling at finer temporal resolution undertaken for the northeast part of the main development site), whilst much of the Sizewell Marshes SSSI will remain unaffected by these noise levels throughout the entire construction phase. However, it is also possible (albeit unlikely) that noise levels of greater than 80 dB $L_{Amax}$ across the main development site could act as a barrier to the movement of foraging marsh harriers from the Minsmere reedbeds to Sizewell Marshes. Therefore, this area of habitat (comprising an estimated 65 ha of grazing marsh and 13 ha of reedbed) could effectively be ‘lost’ in its entirety as a foraging resource to marsh harriers in Phases 1 and 2 as a consequence of any such barrier effect.

1.4.103 Taking into account the duration of the modelled phases as described above, it is considered, from the perspective of potential disturbance effects which may impact at a population level, that the footprints from the worst-case predictions for Phases 1 and 2 provide a highly precautionary basis for determining the total area of habitat that could be affected by noise levels >70 dB $L_{Amax}$. These two phases encompass the largest predicted footprints for noise >70 dB $L_{Amax}$ and, as detailed above, represent worst-case scenarios which overestimate the extent of the 70 dB $L_{Amax}$ footprint which would actually occur at any one point in time.

1.4.104 For the purposes of this assessment it has been assumed that habitat within the 70 dB $L_{Amax}$ footprint would be unavailable to foraging marsh harriers and that the whole extent of the Sizewell Marshes would also be unavailable due to the potential for a barrier effect to arise. The calculated habitat areas assumed to be 'lost' to noise disturbance are based on the worst-case predictions for each of Phases 1 and 2 (with separate calculations made for each phase). As described above, these are considered to provide highly precautionary scenarios.

*Night-time noise levels*

1.4.105 As outlined above (**Section 4.7 ii**), construction activities at the main development site would be limited during the night-time period so that noise levels would be considerably lower than those generated during the daytime period. Given that daytime noise levels are predicted to be below 55 dB $L_{Amax}$ at the Minsmere breeding site and that marsh harriers do not forage at night, any night-time construction activities would not affect the marsh harrier population of the Minsmere-Walberswick SPA and Ramsar site and Minsmere to Walberswick Heaths and Marshes SSSI.

*Extent of predicted visual disturbance effects*

1.4.106 Visual disturbance effects could arise from construction activities occurring within the main development site in locations where screening around the main development site is not present. In these situations, it is possible that disturbance to marsh harrier (and potential displacement from foraging habitat) due to the visual stimuli could occur.

1.4.107 As detailed above (**Section 4.7 ii; Figure 14B2.5**), much of the main development site is contained within the coniferous plantation of Dunwich Forest and this will provide screening around parts of the main development site (either because it extends beyond the boundary or will be retained along the border), whilst wooded field boundaries and small woodlands in other areas will also act to obscure visibility of the main development site from surrounding areas. However, some activities within the main development site will likely remain visible to foraging marsh harriers, including tall structures such as cranes and large stockpiles.

1.4.108 Although Ruddock and Whitfield (2007) (Ref. 1.16) indicated that buffer zones of 300 – 500 m were appropriate for minimising disturbance to marsh harriers at their breeding locations (during egg-laying and chick-rearing), it is considered that applying a 150 m buffer (subsequently termed the potential visual impact zone) around the main development site represents a realistic and sufficiently precautionary approach in relation to potential visual disturbance to foraging birds from construction activities. This is on the basis of the reported low sensitivity of marsh harriers to the potential displacement effects of wind farms (Ref. 1.17), in conjunction with the extent of screening that will occur around the main development site and the low flight heights that are typical of marsh harriers when foraging. However, no visual impact zone is applied around the water storage area in the north-east of the main development site (**Figure 14B2.5**) because the construction works for this part of the development would be limited to the first winter of the construction period only (see **Section 4.7 ii**).

1.4.109 This simple approach of applying a uniform buffer around the main development site is adopted because the exact area over which visual disturbance and potential displacement of birds might arise is clearly difficult to determine with any certainty due to factors such as variation in flight heights, flight directions and, over time, the habituation of birds to the presence of relatively static plant and structures.

1.4.110 The assumption is that foraging marsh harrier outside a potential visual impact zone which extends 150 m around the main development site boundary will not be disturbed by the presence of human movement or infrastructure within the main development site. As displacement of harriers could also arise as a result of increased noise levels around the main development site, it is assumed that only in those locations where the zone of potential visual disturbance extends beyond the predicted footprint of the <70 dB $L_{Amax}$ noise contour is there potential for displacement as a result of visual stimuli (see **Figure 14B2.5**).

### Operation (relevant to all bird species)

1.4.111 Noise levels associated with the operation of the Sizewell C Project are unlikely to differ substantially from the existing baseline situation. This is also considered to be the case for visual disturbance, except in relation to artificial lighting. Operational lighting of the Sizewell C power station platform and a small number of other areas, detailed below, would increase light levels and could cause light intrusion into adjacent habitats.

1.4.112 During the operational phase, lighting would be present on the Sizewell C power station platform, comprising perimeter lighting on fences of 10-20 lux and lighting within the Sizewell C power station platform of 5-20 lux. Outside this area, the access road to the Sizewell C power station, at the location of the SSSI crossing and adjacent land to the north would be lit at 5-10 lux, the car park (within former Goose Hill area) would be also lit at 5-10 lux. Lighting at the roundabout on Abbey Road would be at 10-30 lux, in line with highways requirements, but the access road between this roundabout and the car park would not be lit, except for one area at the north edge of Goose Hill where lighting (ambient levels of 10-20 lux, occasionally up to 100 lux) would be required for a vehicle search area.

1.4.113 The proposed sub-station south of the access road, between Leiston Old Abbey and the Upper Abbey Bridleway would be lit at 5-20 lux, and the Back-up Emergency equipment Store and Back-up Generator buildings next to Upper Abbey Farm would be lit at 5-20 lux.

1.4.114 Consequently, no part of the site would be subject to ambient light levels above 30 lux, and there would be no lighting at all between the Upper Abbey Bridleway and Goose Hill. Light spillage from these proposals would not affect the areas used by the bird populations of nearby and adjacent SPAs, Ramsar sites and SSSIs.

### ii. Disturbance in the marine environment

1.4.115 Relevant ornithological IEFs potentially affected by this impact pathway include:

- Breeding populations of qualifying seabird species at Minsmere-Walberswick SPA/Ramsar and Outer Thames Estuary SPA;
- Breeding populations of little tern and common tern, and non-breeding populations of red-throated diver at Outer Thames Estuary SPA; and
- Breeding kittiwake population on the Sizewell Rigs CWS.

#### Construction and decommissioning

1.4.116 The breeding and non-breeding populations of the designated sites listed above, and of kittiwake on the Sizewell Rigs, could be affected by noise and visual disturbance when away from the nesting colony (in the case of breeding populations) and foraging in the marine environment. Such effects could occur as a result of direct disturbance to the birds themselves from increased vessel traffic or indirectly as a result of the effects of underwater noise on fish prey species.

*Direct disturbance from vessel traffic*

1.4.117 Delivery of rock armour and AILs by barges would cause increased vessel movements within the waters around Sizewell. The construction and installation of the cooling water intake and outfall headworks and construction of the BLF (including the navigational channel) would also be sources of underwater noise, which may affect the fish prey. Artificial lighting would be used at the BLF but this would be highly localised in its effects.

1.4.118 During the construction period, it is expected that there would be approximately 180 AIL deliveries to the BLF, most of which would occur between 31st March to 31st October and encompass the breeding periods of those breeding seabirds associated with the Minsmere-Walberswick SPA/Ramsar and the Outer Thames Estuary SPA (Ref. 1.7) , as well as the kittiwake population on the Sizewell Rigs. This is likely to represent (at most) just over two vessel movements on average per day during the seabird breeding period (given that one delivery would require vessel movements both to and from the BLF).

1.4.119 With regard to the non-breeding red-throated diver population of the Outer Thames Estuary SPA, the main period of increased vessel activity would have little overlap with the period of the year in which red-throated divers are present within the SPA, with April being the only month when the main period of BLF deliveries may coincide with a relatively high abundance of red-throated diver within the waters around Sizewell.

1.4.120 Existing marine traffic in the waters adjacent to the main development site (out to 12nm) include various types of vessels, with the most frequent being cargo, recreational, fishing and wind farm support vessels. During surveys in the summer months an average of 72 vessels were observed per day (Ref. 1.19). Although this overestimates the numbers of vessels occurring within at least some of the relevant seabird species foraging ranges (e.g. for little tern the likely foraging range extends to only 2.4 km offshore), there is clearly existing vessel traffic within the waters around Sizewell and the increase would represent only a small number of additional daily movements. Furthermore, several of the species of relevance (e.g. little tern and common tern) are considered to be relatively insensitive to sources of anthropogenic disturbance (such as vessel traffic) when foraging within the offshore environment, (Ref. 1.20).

*Indirect effects via effects on prey species*

1.4.121 Effects of underwater noise on the fish prey species of seabird IEFs could include direct mortality, recoverable injury, Temporary Threshold Shifts (TTS)[6] or behavioural responses that could conceivably lead to temporary displacement (Ref. 1.21). The first two types of response are considered both in terms of the instantaneous and cumulative exposure to the noise source, whilst TTS is considered only in relation to cumulative exposure and behavioural responses only in relation to instantaneous exposure. The period for cumulative exposure has been defined as 24 hours (Ref. 1.21).

1.4.122 The criteria and thresholds used to define the different effects on fish vary according to the extent to which fish can detect sound, with three categories of fish identified in this regard. In decreasing order of susceptibility to the effects of underwater noise these are: fish with a swim bladder involved in hearing, fish with a swim bladder not involved in hearing and fish with no swim bladder (Ref. 1.22). The former category includes the main likely prey types (clupeids) of the tern populations of the Minsmere-Walberswick SPA and Outer Thames Estuary SPA.

1.4.123 The noise level thresholds that have been applied for mortality increase across these three categories of fish (from most to least susceptible). However, for recoverable injury, the thresholds are equivalent for the two categories of fish with a swim bladder but are higher for those with no swim bladder, whilst for TTS they are equivalent across all three categories of fish (Ref. 1.21). Equivalent quantitative thresholds have not been established for behavioural responses of fish to underwater noise but, based upon an assessment of the potential for behavioural responses, single-pulse sound exposure levels considered sufficient to cause startle responses have been determined for fish with a swim bladder involved in hearing and for fish with no swim bladder, with this level being lower in the former category (Ref. 1.21).

1.4.124 For all underwater noise impacts described below, the predicted effects are based upon the criteria and thresholds considered applicable to fish with a swim bladder involved in hearing (i.e. those most sensitive to the effects of underwater noise).

1.4.125 Of these, UXO clearance (by underwater detonation) has the potential to generate the greatest instantaneous impacts in terms of underwater noise (Ref. 1.21). However, at the time of writing it has not been confirmed if any UXOs are present in the vicinity of the site. Further assessments would be

[6]Temporary hearing impairment, applicable to fish with swim bladders (which includes the main likely prey types of little tern in waters around Sizewell) and defined as any change in hearing of 6 dB or greater that persists at distances of 2 m to 100 m (Ref. 4.20).

conducted (based on the size and number of the UXO devices to be detonated) should UXO detonations be required.

1.4.126 The extent to which effects are predicted to extend from the remaining noise sources are detailed in **Table 1.4** below, with the areas of extent considered in relation to the likely foraging range of the little terns breeding at the Minsmere colony (within the Minsmere-Walberswick SPA/Ramsar and Minsmere to Walberswick Heaths and Marshes SSSI). This provides context for a breeding seabird IEF with a colony location close to these noise sources and a small foraging range (relative to those for other breeding seabirds).

1.4.127 Amongst the remaining noise sources, drilling for the cooling water intakes and outfalls is predicted to cause effects which extend to within 25 m of source only (**Table 1.4**). The greatest extent of instantaneous impacts would arise as a result of impact piling for the BLF, with the worst-case hammer energy indicating behavioural responses over an area of 9.68 km$^2$ (although the predicted area of effect for the expected hammer energy is considerably smaller). Noise levels sufficient to cause recoverable injury or mortality as a result of impact piling for the BLF would extend over relatively small areas only (**Table 1.4**).

**Table 1.4: Effect of underwater noise from construction activities on fish prey of little tern, and overlap of response area with the predicted foraging area of little terns from the Minsmere colony[1]**

| Activity | Fish response[2] | Worst-case fish auditory impact areas (ha) and maximum ranges (m) for different exposures | | Overlap with foraging range[3,4] (%) |
|---|---|---|---|---|
| | | Instantaneous | Cumulative (24 h) | |
| Impact piling for BLF for likely hammer strike energy scenario (90 kJ) | Mortality | 17m | 1ha<br>70m | <0.1 |
| | Recoverable injury | 17m | 3ha<br>111m | 0.2 |
| | TTS | N/A | 46ha<br>556m | 2.5 |
| | Behaviour | 525ha<br>2,111m | N/A | 29.1 |
| Impact piling for BLF for worst-case hammer strike energy scenario (200 kJ) | Mortality | 27m | 2ha<br>111m | 0.1 |
| | Recoverable injury | 27m | 4ha<br>158m | 0.2 |
| | TTS | N/A | 88ha<br>821m | 4.9 |
| | Behaviour | 968ha<br>2,856m | N/A | 46.5 |

| Activity | Fish response[2] | Worst-case fish auditory impact areas (ha) and maximum ranges (m) for different exposures | | Overlap with foraging range[3,4] (%) |
|---|---|---|---|---|
| | | Instantaneous | Cumulative (24 h) | |
| Drilling (cooling water intakes and outfalls) | Mortality | No effect | <0.25ha <25m | <0.1 |
| | Recoverable injury | No effect | <0.25ha <25m | <0.1 |
| | TTS | N/A | <0.25ha <25m | <0.1 |
| | Behaviour | <25m | N/A | - |
| Dredging - BLF construction | Mortality | No effect | 2ha | 0.1 |
| | Recoverable injury | No effect | 6ha | 0.3 |
| | TTS | N/A | 435ha 1,843m | 24.0 |
| | Behaviour | 682ha 2,352m | N/A | 37.1 |
| Dredging – cumulative[5] | Mortality | No effect | 2ha | 0.1 |
| | Recoverable injury | No effect | 7ha | 0.3 |
| | TTS | N/A | 939ha | < 40.0 |
| | Behaviour | 2,131ha | N/A | 43.3 |

[1]Data derived from BEEMS Technical Report TR312 (Ref. 1.21).

[2]TTS is considered in relation to cumulative exposure only and behavioural responses are considered in relation to instantaneous responses only.

[3]Estimates in relation to instantaneous or cumulative exposure, according to which present areas of effect.

[4]Foraging range as estimated by Parsons *et al.* (2015) (Ref. 1.6).

[5]The cumulative scenario assumes that dredging for the BLF construction coincides with dredging for the south cooling water intake (see text). The percentage overlap with the predicted little tern foraging range is not based upon the total auditory impact area because a proportion of the impact area resulting from dredging for the south cooling water intake is outwith the foraging range.

1.4.128 Dredging would occur for the purposes of construction and maintenance of the BLF, and for the construction of the CDO, FRRs, and the cooling water intakes (north and south) and outfall headworks. The assumed period of continuous exposure for these different dredging activities varies from seven hours over the 24-hour assessment period for the cooling water outfall to the full 24 hours for the BLF construction. These activities would not all occur simultaneously, with the BLF construction likely to be earlier in the construction programme than the activities associated with works associated with the intakes and outfalls. Dredging is anticipated to extend over two days for the BLF construction and 9.5 hours each for the CDO and FRRs. The monthly dredging which may be required for maintenance of the navigable channel near the BLF is anticipated to be of five hours duration (Ref. 1.21).

1.4.129 Mortality and recoverable injury as a result of noise from dredging are predicted to occur over small areas only, with the largest effects from any single dredging activity (i.e. BLF construction) extending over 0.02 $km^2$ and 0.06 $km^2$, respectively (**Table 1.4**). Considerably smaller areas of effect (50% or less) for mortality and recoverable injury are predicted for each of the other dredging activities (Ref. 1.21).

1.4.130 TTS is predicted to occur over larger areas, with dredging for BLF construction again associated with the greatest extent of effect (i.e. 4.35 $km^2$ - **Table 1.4**). Other dredging activities are predicted to result in TTS effects that extend over areas from 0.69 $km^2$ to 3.00 $km^2$ (Ref. 1.21). By contrast, the areas over which instantaneous behavioural responses are predicted to extend are greatest for dredging associated with the intakes and outfall (at 11.56 $km^2$ to 11.91 $km^2$), with each of the remaining dredging activities predicted to cause behavioural responses across an area of similar size to that resulting from dredging for the BLF construction - Ref. 1.21, **Table 1.4**).

1.4.131 Based on what is considered to be a hypothetical worst-case for different dredging activities being undertaken simultaneously, underwater noise effects are also presented for dredging for the BLF construction together with dredging for the south cooling water intake (Ref. 1.21). Under this scenario, the areas over which mortality and recoverable injury are predicted to occur remain small (at 0.02 $km^2$ and 0.07 $km^2$, respectively), whilst TTS is predicted to extend across 9.39 $km^2$ and behavioural responses across 21.31 $km^2$ (**Table 1.4**).

1.4.132 The areas over which the effects of underwater noise on fish are predicted to occur overlap with the predicted foraging range of the little terns from the SPA colony at Minsmere but not with the foraging range of the SPA colony at Dingle (Ref. 1.7). For behavioural responses (resulting mainly from piling and dredging) and TTS (resulting from dredging mainly), the extent of overlap with the foraging range of the Minsmere birds is substantial (**Table 1.4**). However, mortality and recoverable injury of fish as a result of these activities are predicted to extend across small areas only, comprising a small part of the predicted foraging range of little tern from the SPA colony at Minsmere (less than 0.5% in each case).

1.4.133 Behavioural responses of fish (which could range from startle responses to displacement) only have the potential to temporarily affect prey availability to the seabird IEFs, with any reduction in prey availability within the affected area expected to be limited to the duration of the activity. It is unclear exactly how TTS might act to affect the availability of seabird prey. The extent of the duration and magnitude of TTS experienced by the affected fish may be variable, whilst fish experiencing TTS may have reduced fitness (including decreased ability to detect predators) (Ref. 1.22).

1.4.134 Impact piling for the BLF would involve a total of 12 piles only, with each pile being drilled in less than an hour and only five piles within a 24-hour period. Therefore, reductions in prey availability due to impact piling would extend over a period of a few days only. Dredging for the BLF construction is considered (on a precautionary basis) to require continuous activity over the 24-hour period and is anticipated to take just over two days to complete. The dredging for other purposes would require continuous activity over considerably shorter periods of time (generally seven to ten hours - Ref. 1.21).

1.4.135 Of relevance to the Outer Thames Estuary SPA, the potential for mortality and recoverable injury of fish as a result of underwater noise from different construction-related activities are predicted to extend over less than 0.01% of the predicted foraging range of each of the Minsmere and Orfordness common tern colonies, whilst for the hypothetical worst-case scenario of different dredging activities being undertaken simultaneously, the area of effect equates to just over 0.01% of the predicted foraging ranges. The largest predicted areas of effect for TTS and behavioural responses (both resulting from the worst-case simultaneous dredging scenario) represent only approximately 2% and 4%, respectively, of the predicted foraging range of each common tern colony. Other seabird IEFs (e.g. kittiwake breeding on the Sizewell Rigs) have larger foraging ranges, so these effects would likely extend over a smaller percentage of their range.

#### h) Disturbance due to increased recreational pressure

1.4.136 Increased recreational pressure may affect birds directly through increased direct disturbance to birds and indirectly via the effects of recreation on the habitats on which birds depend. Full details of the supporting evidence for the assessment of recreational impacts are provided in **Shadow HRA Report, Appendix E: Recreational Evidence Base** (**Book 5, Report 5.10**).

1.4.137 Relevant ornithological IEFs potentially affected by this impact pathway include:

- Qualifying features (breeding and non-breeding) of the Minsmere-Walberswick SPA/Ramsar and Minsmere to Walberswick Heaths and Marshes SSSI;
- Qualifying features (breeding and non-breeding) of the Alde-Ore Estuary SPA/Ramsar and SSSI;

- Qualifying features (breeding) of the Benacre to Easton Bavents SPA;
- Qualifying features of the Sandlings SPA and component SSSIs;
- Bird assemblage associated with the Sizewell Marshes SSSI;
- Breeding stone curlew.

i. Construction and decommissioning

1.4.138 During the construction (and decommissioning) of the main development site, recreational users of the Sizewell C area may be displaced elsewhere, including to locations which support important ornithological features.

1.4.139 Project-specific visitor surveys were carried out in August and November 2014, involving a questionnaire-based survey and observations at seven survey points within 2km of Sizewell. Survey locations and the questionnaire were discussed in advance with stakeholders. Further user surveys took place at Minsmere RSPB reserve in 2015. During surveys, respondents were asked whether the construction of Sizewell C would impact on their recreational activity in the area and, if so, where they might relocate to should they be affected[7]. Of the respondents questioned, 29% indicated that they would avoid the Sizewell area during construction and seek other locations. This information was used to estimate the potential increase in visits to locations adjacent to or within areas of ornithological importance such as SPAs and Ramsar sites. The assessment also took account of predictions about the potential recreational use of the surrounding area by construction workers from Sizewell C.

1.4.140 The Alde-Ore estuary was identified as a potential alternative location to Sizewell by a total of 30 respondents to the visitor survey (5.8% of 514 respondents). Aldeburgh was identified as the most likely site near to the Alde-Ore Estuary SPA that users could be displaced to, with smaller predicted increases to other locations. Increased visitor use in and around Aldeburgh would be unlikely to impinge directly upon the estuary, which is important for wintering waterbirds such as avocet, redshank and ruff, with the focus of any additional activity likely to be the main beach frontage. Small increases to the access locations at Snape Maltings, Iken and Sailor’s Path would be unlikely to lead to any additional disturbance pressure that would have adverse ecological consequences.

[7] The responses obtained are considered to be also relevant to the decommissioning phase (as far as this is foreseeable).

1.4.141 Increased disturbance pressure to controlled areas at Orfordness and Havergate Island, which are of particular importance for breeding seabird colonies (Sandwich tern, lesser black-backed gulls and other gulls) is not predicted to arise. While increased visitor use at Butley could lead to increased disturbance to saltmarsh and intertidal mudflats in the Butley and the Ore estuaries, via the Suffolk Coastal Path, this location has the lowest estimated number of annual visits and was identified as a potential alternative location by the smallest percentage of survey respondents, so the predicted numbers of increased visits are very small, 0.05 – 2.6 per day.

1.4.142 Little terns have historically nested at Sudbourne Beach, near Slaughden. Sudbourne Beach is potentially accessible via a car park south of the village of Aldeburgh. The Recreational Evidence Base concludes that any increase in visitor numbers as a result of potential displacement from Sizewell C (estimated at 2.9 - 13% for this location) would not increase the disturbance pressure at this site. This takes account of existing access management measures, including prohibition of dogs on the beach between 1 May and 30 September, signage, fencing and vehicle barriers.

1.4.143 Covehithe, in Benacre to Easton Bavents SPA, was not identified as an alternative site to relocate to during the visitor access surveys, therefore no additional recreational pressure is predicted for this site as a result of displacement of visitors during the construction of Sizewell C. Kessingland, also in the SPA, is outside the recreation and access study area but was named as a potential alternative location by a small number of respondents in the survey. However as only 4% of respondents stated they would relocate to sites outside the study area (including, but not limited to Kessingland), any increase in visitor pressure at this site due to construction of Sizewell C is considered likely to be so small as to be undetectable.

1.4.144 The Minsmere to Walberswick area (including Dunwich Forest) was identified as potentially receiving the highest number of displaced people during the 2014 visitor survey, being named by a total of 92 (17.9%) out of the 514 respondents. It was estimated that total visits to access points associated with the SPA could increase by 0.2-3.1% or 1.6-50.3%. The largest potential increase is predicted for the Minsmere-Eastbridge area.

1.4.145 It is considered likely that a large proportion of those who said they would relocate to Minsmere, particularly if local to the Sizewell area, would relocate to sites on the periphery of the RSPB Minsmere Reserve rather than the main reserve itself, as such locations would provide access to the local footpath network without having to access the main Reserve. The 2015 visitor survey at RSPB Minsmere suggested that 27% of visitors to the main reserve could seek alternative sites to visit during construction of SZC.

1.4.146 Mitigation measures have been identified to minimise the ecological effects of increased recreational pressure on habitats and associated species in the Minsmere RSPB Reserve area. A Rights of Way and Access Strategy is being developed, in alignment with the Suffolk RAMS Strategy (Ref. 1.23) to minimise the displacement of existing recreational users from Sizewell C and the likelihood that displaced visitors and construction workers would access sensitive areas (such as the European sites) for recreation. In addition, the strategy outlines a monitoring programme for recreational displacement to identify local mitigation measures, to be agreed with local land managers, which could be introduced to further reduce recreational disturbance.

#### ii. Operation

1.4.147 There is the potential for the recreational response of people displaced by construction activity to be maintained through into the operational phase of Sizewell C. If this were to occur, displacement of recreational users from the Sizewell area to the alternative locations adjacent to and within the designated European Sites under consideration would continue.

1.4.148 The operational workforce for Sizewell C would be considerably less than that during construction. There would be an operational workforce of approximately 900 people, based within 25 miles (40 km) of the main development site. An additional 940 temporary workers would be present for short-term periods (8-10 weeks) twice a year for planned outages.

#### i) Physical interactions between species and Project infrastructure

1.4.149 Relevant ornithological IEFs potentially affected by this impact pathway include:

- Qualifying features (breeding and non-breeding) of the Minsmere-Walberswick SPA/Ramsar and Minsmere to Walberswick Heaths and Marshes SSSI;
- Qualifying features (breeding and non-breeding) of the Alde-Ore Estuary SPA/Ramsar and SSSI;
- Qualifying features (breeding) of the Benacre to Easton Bavents SPA;
- Qualifying features (breeding and non-breeding) of the Outer Thames Estuary SPA;
- Bird assemblage associated with the Sizewell Marshes SSSI; and

- A wide range of the other ornithological IEFs listed in **Table 3.2** including non-qualifying populations associated with the SPAs and Ramsar sites and SSSIs identified above, and ornithological IEFs reliant on non-designated habitats within and in close proximity to the main development site.

i. Construction

1.4.150 During the construction phase, there is the potential for birds to come into contact with proposed development infrastructure, for example, through road traffic accidents and collision with new pylon infrastructure. The development proposals require the repositioning of one existing overhead pylon and four new overhead gantries.

1.4.151 However, there would be no significant increase in the extent of overhead lines (compared to the cabling already in place within the existing complex) and the new pylon and gantries would be within the footprint of the main platform. On this basis, it is concluded that there is very limited potential for a significant impact to occur on any of the ornithological IEFs.

ii. Operation

1.4.152 During the operation of the Sizewell C Project, populations of the fish and invertebrate prey of seabird species may be affected by impingement or entrainment within the cooling water intake, leading to potential indirect impacts on the SPA populations. Based on the predicted foraging ranges described in Section 6.3 of the **Shadow HRA Report (Book 5, Report 5.10)**, SPA populations of Sandwich tern, common tern, little tern, lesser black-backed gull and red-throated diver may forage in waters around the main development site, as well as other seabird species. Key prey species of foraging seabirds include clupeids (herring and sprat) and sandeels. Red-throated divers may also feed on whiting, smelt and sand gobies.

1.4.153 Mitigation measures in place to reduce the magnitude of this effect pathway include the incorporation of low velocity side entry (LVSE) intake heads and the FRR system into the design.

1.4.154 Based on sampling from Sizewell B, an assessment of the entrainment effects indicates that the predicted losses of the local (ICES region) Spawning Stock Biomass (SSB; a measure of fish population size of species for which data are available) are less than <0.001%. Similarly, predicted entrainment effects on invertebrate zooplankton are also assessed to be negligible.

1.4.155 Combined impingement and entrainment effects on fish have been assessed by comparing the predicted annual mortality of a given species (EAVs) as a percentage of the SSB. For commercially exploited stocks and conservation species, a threshold of 1% of the SSB, is identified as a level below which there would be negligible effects on the year-to-year sustainability of the fish population. If an SSB estimate is not available, then a highly conservative proxy of 1% of international landings is used. For unexploited stocks, the equivalent thresholds are 10% or the SSB or 10% of international landings

1.4.156 Sprat and herring were the most frequently recorded species impinged at Sizewell B. For sprat the estimated annual mortality for Sizewell C with the LVSE and FRR in place was 2,249,905 EAV, equivalent to 0.01% of the SSB for the ICES North Sea stock area for this species. For herring the estimated annual mortality with the FRR in place was 724,095 EAV, equivalent to 0.01% of the SSB for the ICES North Sea, Skagerrak and Kattegat and Eastern Channel stock area for this species.

1.4.157 Sandeels were insufficiently abundant in the available fish datasets for Greater Sizewell Bay to be considered a key species in the local fish assemblage. Entrainment predictions for all sandeel species combined at Sizewell C were an upper estimate of 18,999 fish per year equivalent to 0.0001% of SSB. Unmitigated impingement estimates of 1,459 (112-19,034), 44 (18-104) and 8,128 (no upper and lower estimates provided) individuals per year are given respectively for great sandeel, Raitt's sandeel and common sandeel. Combined impingement and entrainment predictions are not presented, nevertheless the estimates indicate that the combined effect is likely to be considerably lower than 1% of SSB. For cod, whiting, smelt and sand goby respectively the estimated annual impingement and entrainment mortality was 1,395, 140,044, 6,959 and 2,922,306 EAV, equivalent to 0.00%, 0.03%, 0.01% and 1.41% of SSB.

1.4.158 As such, impingement mortality is predicted to have a negligible effect on the SSB populations of key prey species for seabirds. Impacts are likely to be so small as to be undetectable in the context of year to year variation in fish populations due to other environmental factors.

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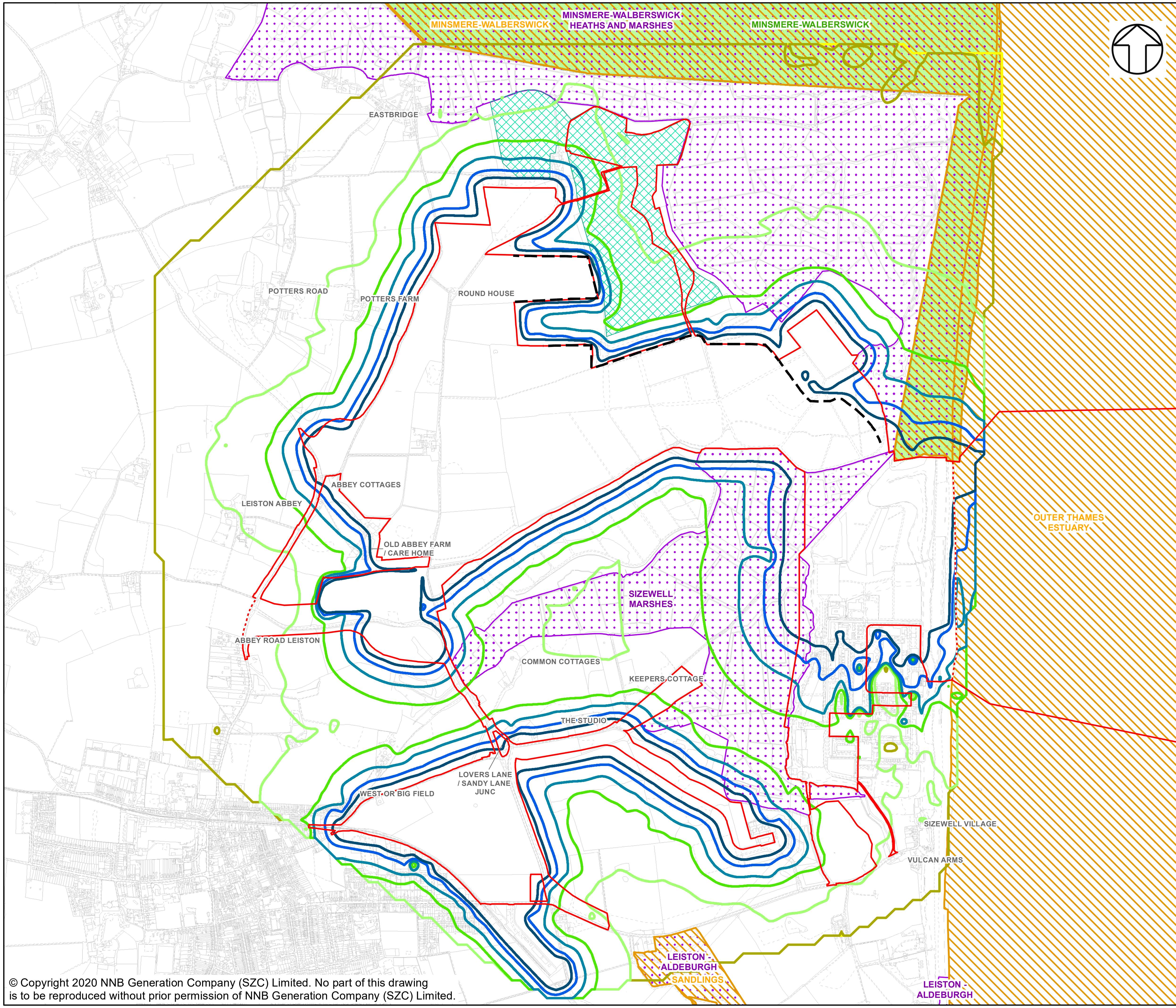
## Appendix 14B2.1: Figures






NOTES

KEY

- SIZEWELL C MAIN DEVELOPMENT SITE BOUNDARY
- DEMARCATION LINE
- HARRIER HABITAT IMPROVEMENT AREA
- FENCE

**DESIGNATIONS**

- SPECIAL PROTECTION AREA (SPA)
- SITE OF SPECIAL SCIENTIFIC INTEREST (SSSI)
- RAMSAR SITE

**PHASE 1 - 5M BARRIER**

**NOISE LEVEL $L_{Amax}$ (DB)**

- <= 54
- 54 - 64
- 64 - 70
- 70 - 74
- 74 - 79
- 79 - 84
- >84

NOT PROTECTIVELY MARKED



DOCUMENT:
SIZEWELL C
ENVIRONMENTAL STATEMENT
VOLUME 2
APPENDIX 14B2
ORNITHOLOGY SYNTHESIS REPORT

DRAWING TITLE:
PREDICTED PEAK NOISE AT 3M ELEVATION FOR PHASE 1 CONSTRUCTION FOR SIZEWELL C WITH 5M HIGH FENCE IN PLACE (BORROW PIT OPTION 2 - AREAS 1 AND 2)

DRAWING NO:
FIGURE 14B2.1

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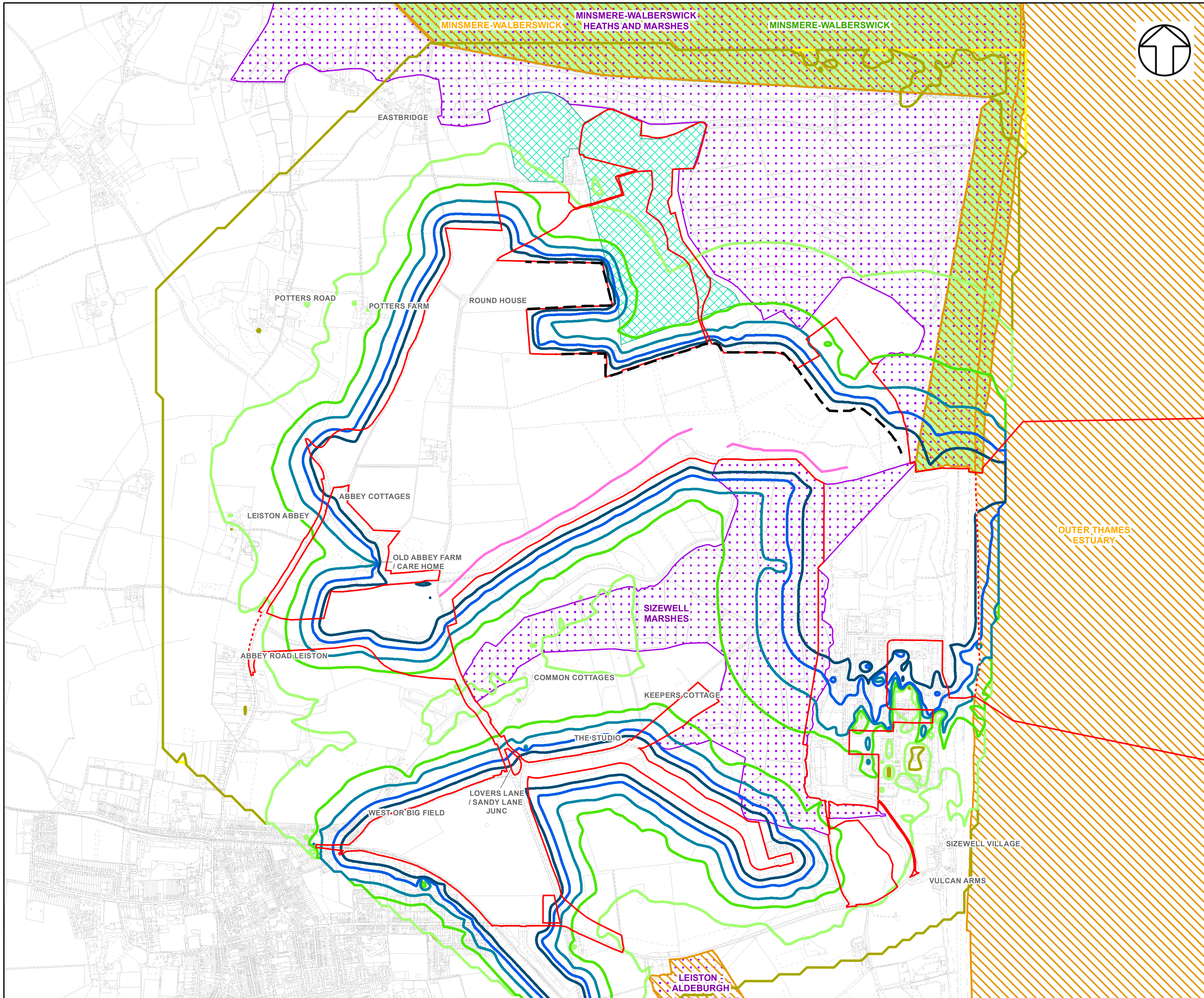




NOTES

KEY

- SIZEWELL C MAIN DEVELOPMENT SITE BOUNDARY
- DEMARCATION LINE
- HARRIER HABITAT IMPROVEMENT AREA
- BUND
- FENCE

**DESIGNATIONS**

- SPECIAL PROTECTION AREA (SPA)
- SITE OF SPECIAL SCIENTIFIC INTEREST (SSSI)
- RAMSAR SITE

**PHASE 2**

**NOISE LEVEL $L_{Amax}$(DB)**

- <= 54
- 54 - 64
- 64 - 70
- 70 - 74
- 74 - 79
- 79 - 84
- >84

NOT PROTECTIVELY MARKED



DOCUMENT:
SIZEWELL C
ENVIRONMENTAL STATEMENT
VOLUME 2
APPENDIX 14B2
ORNITHOLOGY SYNTHESIS REPORT

DRAWING TITLE:
PREDICTED PEAK NOISE AT 3M ELEVATION FOR PHASE 2 CONSTRUCTION FOR SIZEWELL C (BORROW PIT OPTION 2 - AREAS 1 AND 2)

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FIGURE 14B2.2

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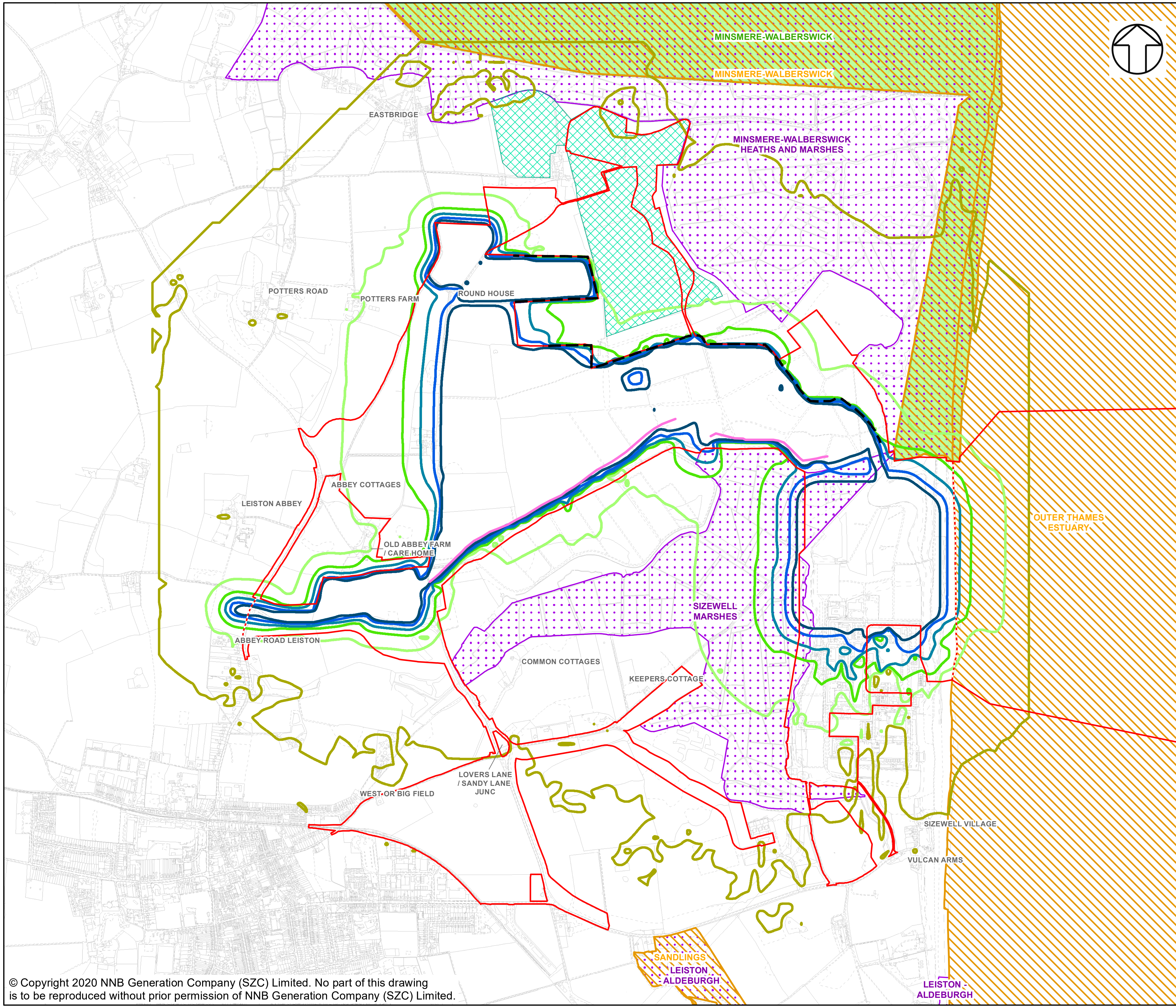




NOTES

KEY

- SIZEWELL C MAIN DEVELOPMENT SITE BOUNDARY
- DEMARCATION LINE
- HARRIER HABITAT IMPROVEMENT AREA
- BUND
- FENCE

**DESIGNATIONS**

- SPECIAL PROTECTION AREA (SPA)
- SITE OF SPECIAL SCIENTIFIC INTEREST (SSSI)
- RAMSAR SITE

**PHASES 3 AND 4**

**NOISE LEVEL $L_{Amax}$(DB)**

- 54 - 64
- 64 - 70
- 70 - 74
- 74 - 79
- 79 - 84
- >84

NOT PROTECTIVELY MARKED



DOCUMENT:
SIZEWELL C
ENVIRONMENTAL STATEMENT
VOLUME 2
APPENDIX 14B2
ORNITHOLOGY SYNTHESIS REPORT

DRAWING TITLE:
PREDICTED PEAK NOISE AT 3M ELEVATION FOR PHASES 3 AND 4 CONSTRUCTION FOR SIZEWELL C

DRAWING NO:
FIGURE 14B2.3

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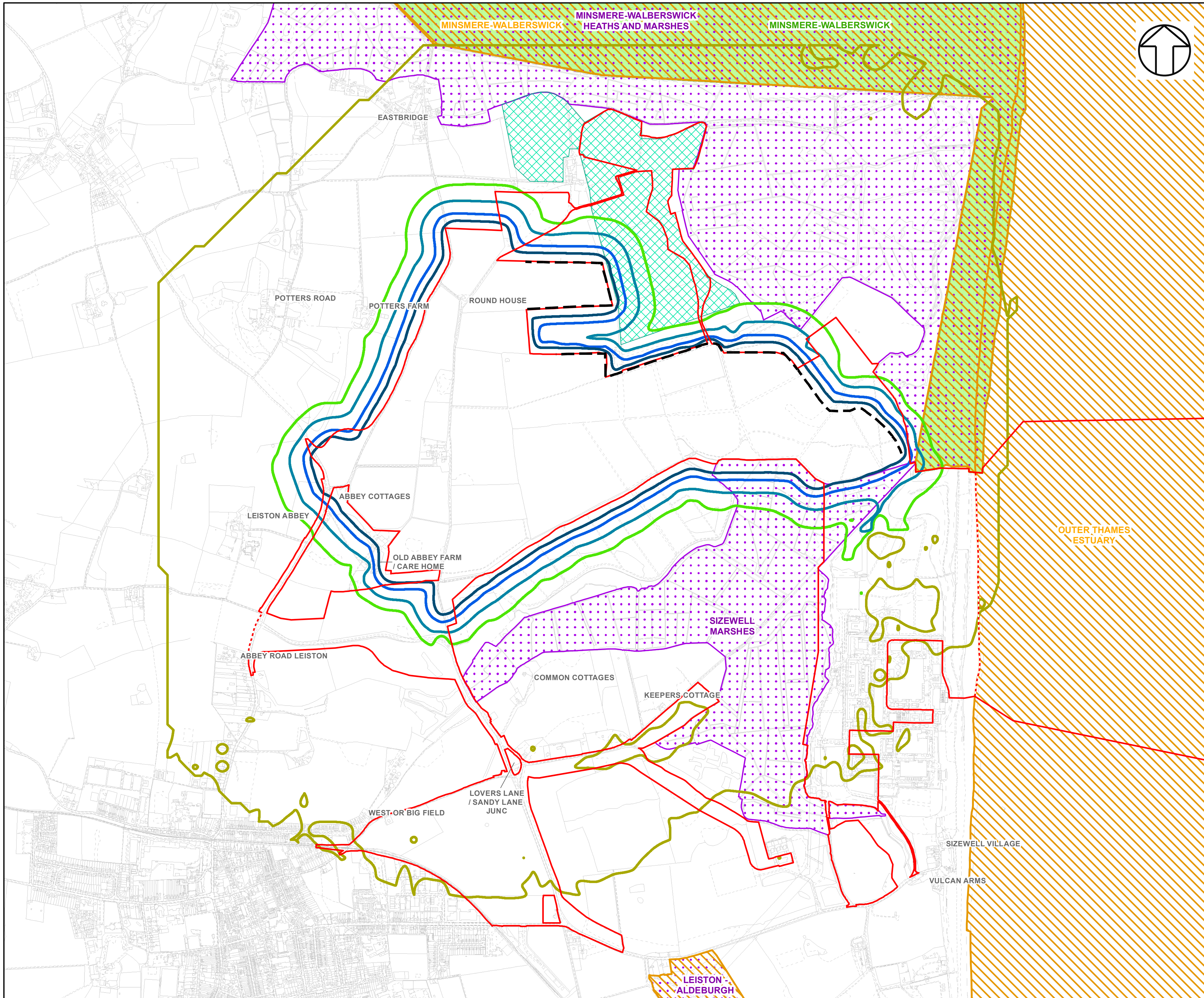




NOTES

KEY

- SIZEWELL C MAIN DEVELOPMENT SITE BOUNDARY
- DEMARCATION LINE
- HARRIER HABITAT IMPROVEMENT AREA
- FENCE

**DESIGNATIONS**

- SPECIAL PROTECTION AREA (SPA)
- SITE OF SPECIAL SCIENTIFIC INTEREST (SSSI)
- RAMSAR SITE

**PHASE 5**

**NOISE LEVEL $L_{Amax}$(DB)**

- 54 - 64
- 70 - 74
- 74 - 79
- 79 - 84
- >84

NOT PROTECTIVELY MARKED



SZC edf ENERGY CGN

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DRAWING TITLE:
PREDICTED PEAK NOISE AT 3M ELEVATION FOR PHASE 5 CONSTRUCTION FOR SIZEWELL C

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FIGURE 14B2.4

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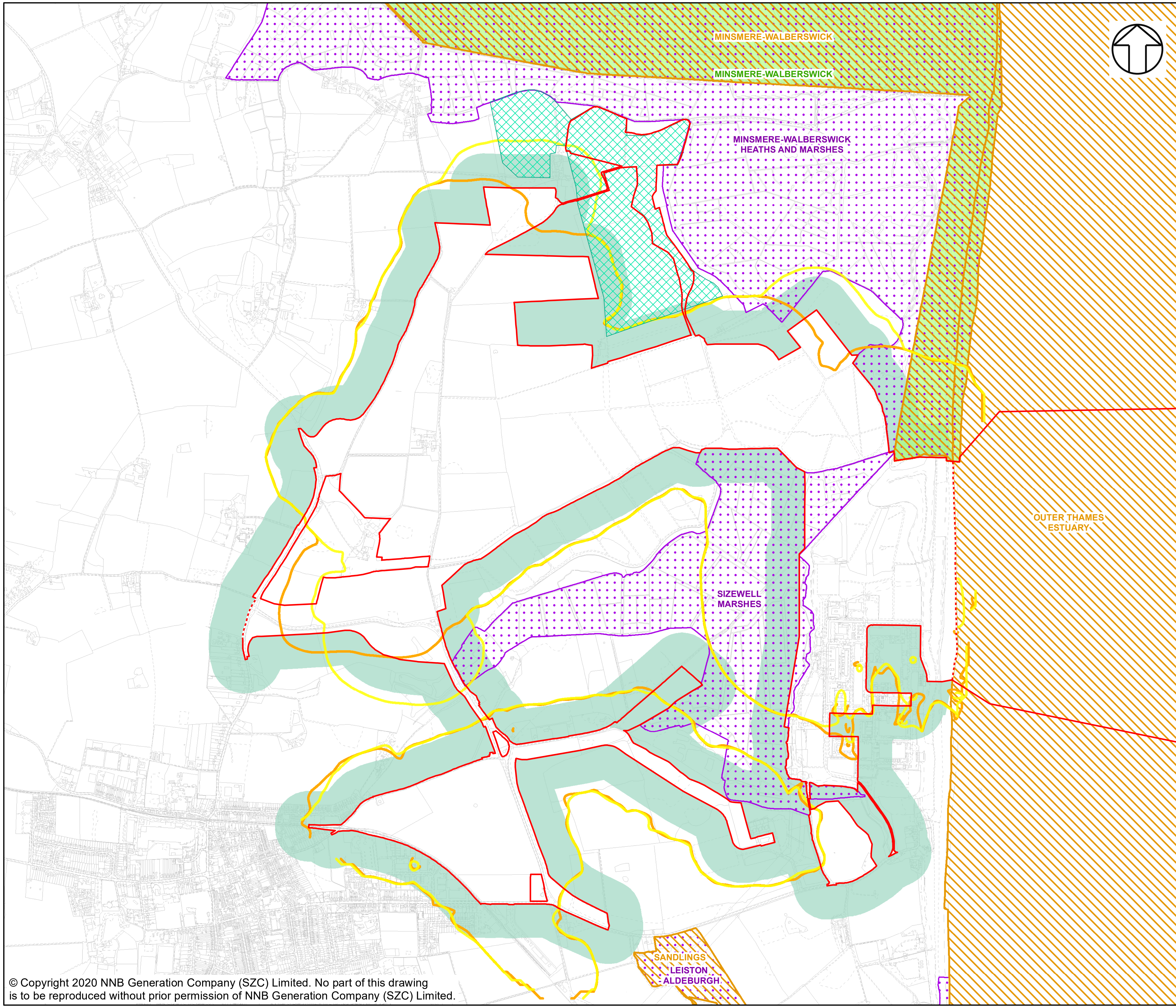




NOTES

KEY

- SIZEWELL C MAIN DEVELOPMENT SITE BOUNDARY
- DEMARCATION LINE
- HARRIER HABITAT IMPROVEMENT AREA
- 150M BUFFER OF VISUAL DISTURBANCE

**DESIGNATIONS**

- SPECIAL PROTECTION AREA (SPA)
- SITE OF SPECIAL SCIENTIFIC INTEREST (SSSI)
- RAMSAR SITE

**PHASE 1 - (INCLUDING 5M FENCE)**

**NOISE LEVEL $L_{Amax}$(DB)**

- 70

**PHASE 2**

**NOISE LEVEL $L_{Amax}$(DB)**

- 70

NOT PROTECTIVELY MARKED



DOCUMENT:
SIZEWELL C
ENVIRONMENTAL STATEMENT
VOLUME 2
APPENDIX 14B2
ORNITHOLOGY SYNTHESIS REPORT

DRAWING TITLE:
THE 70DB $L_{Amax}$ NOISE CONTOURS FOR THE WORST-CASE PREDICTIONS FOR PHASES 1 AND 2 OF CONSTRUCTION, WITH THE 150M IMPACT ZONE FOR VISUAL DISTURBANCE

DRAWING NO:
FIGURE 14B2.5

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NOTES

KEY

- SIZEWELL C MAIN DEVELOPMENT SITE BOUNDARY
- DEMARCATION LINE
- VISUAL DISTURBANCE BUFFER
- VISUAL DISTURBANCE BUFFER FOR CONSTRUCTION OF THE WATER STORAGE AREA (RELEVANT TO THE FIRST WINTER OF THE CONSTRUCTION PERIOD ONLY)

DESIGNATIONS

- SPECIAL PROTECTION AREA (SPA)
- SITE OF SPECIAL SCIENTIFIC INTEREST (SSSI)
- RAMSAR SITE

NOT PROTECTIVELY MARKED



DOCUMENT:
SIZEWELL C
ENVIRONMENTAL STATEMENT
VOLUME 2
APPENDIX 14B2
ORNITHOLOGY SYNTHESIS REPORT

DRAWING TITLE:
THE EXTENT OF THE IMPACT ZONE WITHIN WHICH IT IS ASSUMED THAT THERE IS POTENTIAL FOR VISUAL DISTURBANCE EFFECTS ON WATERBIRDS AS A RESULT OF CONSTRUCTION ACTIVITIES

DRAWING NO:
FIGURE 14B2.6

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# Appendix 14B2.2: Evidence Base for Potential Effects of Anthropogenic Disturbance (noise and visual disturbance) on Breeding and Wintering Waterbirds

## 1.1. Introduction

1.1.1. Humans and human activity can cause disturbance effects on birds via noise and visual stimuli, with these stimuli potentially leading to a range of impacts as summarised below, after Liley *et al*. (2015 - Ref. 1.1) and others (e.g. Ref. 1.2, Ref. 1.3):

- redistribution / displacement (short-term or long-term avoidance) of birds in response to the presence of people;
- reduced intake-rate of food due to birds feeding in areas with poorer available food resources, or by disturbance (e.g. increased noise) directly reducing prey detection rates or altering the distribution of food sources;
- increased energy expenditure as a result of birds reacting to disturbance by flying to different areas to feed and being flushed while feeding and roosting;
- interference with auditory communication signals (e.g. bird song);
- physiological impacts, such as increased stress, which may also have consequences for energy expenditure; and
- direct mortality, such as predation from domestic dogs, predators exploiting disturbance events or nests being trampled.

1.1.2. While it is acknowledged that studies demonstrating the consequences of disturbance on population size, rather than effects on behaviour, are most useful for providing evidence of impacts on a species (Ref. 1.4), long-term studies of the effects of disturbance at the population level are currently lacking.

1.1.3. Where the disturbance source is associated with the direct presence of humans, the response can be considered as a trade-off between access to, or use of, a certain resource and the perceived predation risk posed by humans (Ref. 1.5; Ref. 1.6). Above a certain threshold of disturbance, perceived threats outweigh potential benefits (Ref. 1.7). Behavioural responses to disturbance, for example flushing, can be seen as part of a continuum towards complete avoidance of certain areas.

1.1.4. In the case of wintering waterbirds, interference with feeding and roosting activities is usually the primary cause for concern in relation to disturbance effects because this may lead to long-term, adverse, consequences. Repeated disturbance may result in birds taking flight, thereby expending energy and depleting energy reserves that are required for successful migration and / or over-winter survival (particularly during periods of intense or prolonged cold weather). Habitat that is suitable for breeding / wintering birds may also become unavailable as a result of disturbance and effectively represents a form of habitat loss (Ref. 1.8).

1.1.5. The responses of wintering waterbirds to disturbance stimuli may vary greatly and the sensitivity of species varies with factors such as weather, age, and habitat use (Ref. 1.9). Habituation may arise if disturbance events are relatively frequent, although again, some species exhibit a greater capacity for habituation than others (Ref. 1.10).

1.1.6. In the case of breeding waterbirds, and other ground-nesting birds, disturbance may not only affect feeding activities but also has the potential to lead to direct effects on breeding productivity, via increases in predation rates on nests or chicks, chilling of eggs, desertion of nests or abandonment of breeding areas (Ref. 1.11, Ref. 1.4; Ref. 1.12; Ref. 1.13).

1.1.7. The term displacement is used to describe the movements away from areas that normally would be used in the absence of disturbance or other perturbations and, as such, can reflect either short distance movements within a home-range (both walked or flown) or longer distance movements to unfamiliar areas. The impacts of displacement on individuals are then moderated by (for short distance movements):

- the importance of the area of the home-range being disturbed (i.e. its value as a foraging resource or secure roosting area); and

- the length of time and frequency that the area is disturbed (e.g. influenced by the duration of events and the number of disturbance events per hour).

1.1.8. For example, a single disturbance event from an area of the home-range used infrequently will have a different impact to that associated with frequent disturbance of a core foraging area. Also, the effects are likely to differ according to whether displacement is from a wintering or breeding season home range or territory.

1.1.9. The effects of displacement or movements away from the home-range are governed by a number of factors, including the:

- length of time and frequency that the area is disturbed (e.g. influenced by the duration of events and the number of disturbance events per hour);
- availability of other suitable habitat in the general area;
- quality of other suitable habitat in the general area;
- ability of displaced individuals to exploit unfamiliar habitat patches; and
- level of competition within other suitable habitat in the general area.

1.1.10. Similarly, effects of disturbance on breeding productivity are likely to vary according to a range of factors, including the stage of the breeding cycle (e.g. pre-laying, incubation or chick-rearing) at which disturbance occurs, the types and abundance of predatory species present within the breeding areas and other factors that may affect the condition of the breeding waterbirds (e.g. food availability) (Ref. 1.12).

1.1.11. Because of the variability of response between species and in respect of the nature of the stimuli and conditions, quantifying the (observed or potential) effects of disturbance, particularly at the population level, is challenging. Therefore, the assessment of effects has to rely largely on documented observations of the response of waterbirds to stimuli (e.g. noise from human activities, human presence, activities such as walking etc.) and the application of these findings to specific situations.

## 1.2. Noise disturbance evidence base

1.2.1. Because of their reliance on acoustic communication, birds have been viewed as potentially vulnerable to changes in their noise environment that may be caused by anthropogenic activity. Anthropogenic noise has been associated with reduced bird densities, as a result of displacement from otherwise suitable habitat due to ecological sensitivities or intolerance to noise. Studies suggest that noise may disrupt acoustic communication, interfere with detection of warning signals or prey and elevate stress levels (see above).

1.2.2. Infrequent activities / operations that can generate intense noise levels (e.g. aircraft activity in remote areas, intermittent industrial activities) in a relatively small area may lead to species abandoning areas of suitable habitat. Evidence from studies into this type of noise pollution indicate that generally birds, if undertaking a flight response, are likely to return to the affected area if the noise is generally infrequent and has dissipated (Ref. 1.14, Ref. 1.15).

1.2.3. Chronic anthropogenic noise from busy roads, urban areas, and permanent industrial structures has been implicated as having detrimental impacts upon breeding bird populations. Although many such studies fail to disentangle the effects of noise from potentially confounding effects that may be associated with proximity to roads (e.g. visual disturbance or associated habitat variation), other recent studies have demonstrated such effects using experimental designs that control for confounding effects (Ref. 1.16, Ref. 1.2). The effects of such chronic anthropogenic noise appear to vary between species, with responses in breeding densities apparent in some species only (Ref. 1.17, Ref. 1.16, Ref. 1.2). Possible explanations for such variable responses include differences in the hearing sensitivity of species or in their song or call structure, affecting the extent to which these are masked by the anthropogenic noise.

1.2.4. To help establish the basis for predicting the extent to which noise disturbance effects may extend from the main development site, a brief summary of some of the key findings of studies on the influence of noise on bird populations and communities is provided in the following sections. This evidence base provides the foundation for assessing the likely response of waterbirds to increased noise levels during the construction phase for Sizewell C. Many of the studies undertaken to date relate to the effects of traffic / road noise on birds, although more recently, some studies have focused on chronic industrial noise and its effects.

### a) Impulsive-type construction noise

1.2.5. Work by the Institute for Estuarine and Coastal Studies (IECS) on wintering waterbirds has provided data on the noise levels at which a behavioural response reaction from birds is elicited (Ref. 1.18; Ref. 1.19). This work categorises disturbance responses based on potential sources, with the following attributed to noise levels:

- Irregular piling noise (above 70dB) — High to Moderate
- Regular piling noise (above 70dB) — Moderate
- Irregular noise (50dB - 70dB) — Moderate
- Regular noise (50dB - 70dB) — Moderate to Low
- Noise below 50dB — Low

1.2.6. Disturbance generated by the noise levels reported above was observed to lead to the interruption of birds’ normal activity patterns and / or short-distance displacement from the area of disturbance (Ref. 1.19, Ref. 1.15). Studies suggest that any effects are temporary and in only a small number of cases have disturbance events actually been shown to cause birds to permanently vacate a site.

1.2.7. Studies on wintering waterbirds in the Waddenzee (Netherlands) have revealed that high noise levels associated with military activity (shooting, low flying aircraft) can lead to significant disturbance, particularly for roosting birds. Smit and Visser (1993 - Ref. 1.20), in a review of information and studies record that, at Vlieland, bombing and rocket shooting from jets (which occur for most of the year) yield sound levels of 84-100 dB(A) at 5 km from the firing range. At roost sites in the area, surveys show that the total numbers of ducks, waders and gulls in the heavily disturbed area were reduced from 69,000 prior to shooting sessions (Monday-Friday) to 38,000 during the shooting sessions. Roosting birds were found to continue to respond to shooting activities in the area despite the fact that shooting activities had been ongoing for a period of 40 years. Smit and Visser (1993 - Ref. 1.20) attribute this continued disturbance effect to the high noise levels and the use of different ammunition types which generate strong differences in sound levels. However, Smit and Visser (1993 - Ref. 1.20) also report that shooting activities at Vlieland have little visible effects on feeding waders. Prey choice, behaviour and intake rates of oystercatcher and curlew were not different on days with and without shooting although the diversity of feeding shorebirds south of Vlieland was higher on days without shooting, suggesting that some species are less tolerant of high noise levels.

1.2.8. Wintermans (1991 - Ref. 1.21, referenced in Smit and Visser (1993 - Ref. 1.20), studied the effects from a shooting range in the Marnewaard (Waddenzee) and found no indications for a lower diversity of waterbirds on the tidal flats. This was attributed to lower noise levels (between 43- 87 dB(A)) in the area, compared to those recorded in Vlieland by Smit and Visser (1993 - Ref. 1.20).

1.2.9. Little evidence is available pertaining to the effects of impulsive noise on breeding waterbirds. However, waterbirds are known to breed in areas that are subjected to frequent impulsive noise from anthropogenic activities, such as at the SWT's Trimley Marshes reserve[8]. This site is adjacent to the Felixstowe Port, with noise monitoring showing that maximum noise levels at the site from the port activities are variable but, on some days, can exceed 70 dB, $L_{Amax}$ one to three times an hour and 65 dB, $L_{Amax}$ 10 times an hour (Ref. 1.22).

1.2.10. Gull and tern species will also breed within, and close to, ports and docks (e.g. Ref. 1.23), whilst both monitoring of anthropogenic noise events and

[8] https://www.suffolkwildlifetrust.org/trimleymarshes

experimental studies generating aircraft noise at breeding colonies have shown that in, some situations at least, certain gull and tern species tend to show limited responses only to impulsive noise events of less than 75dB $L_{Amax}$ (Ref. 1.24, Ref. 1.25; Ref. 1.26).

b) Chronic noise disturbance

1.2.11. Chronic noise disturbance effects may be associated with a number of anthropogenic noise sources, in particular road traffic and industrial installations.

1.2.12. Some birds may be sensitive to noise resulting from human activities because auditory signals used for communication or (in the case of some predatory species) prey detection may be masked by the anthropogenic noise. Noise that distorts or masks communication signals may influence population density, mating behaviour, and breeding success; ambient noise may reduce male to female communication, increase redundancy of songs, drown out begging calls, or inhibit predator detection. Noise may affect bird community structure by favouring certain species (e.g. Ref. 1.27; Ref. 1.28), whilst it has been shown to reduce prey detection by hunting owls (Ref. 1.29; Ref. 1.30).

1.2.13. Habib *et al*. (2007 - Ref. 1.31) found a reduction in pairing success and a higher proportion of inexperienced ovenbirds at industrial well compressor stations compared with control sites surrounding habitat-disturbed but noiseless stations. Bayne *et al*. (2008 - Ref. 1.32) found a 30% reduction in songbird density at noisy gas compressor stations in Canada compared with nearby well pads that were almost identical in habitat, but were much quieter, thus suggesting that disturbance through increased noise levels was a factor in the reduced breeding density. Francis *et al*. (2009 - Ref. 1.27) used a similar system of noisy gas compressors and quiet well pads in New Mexico to show that species richness of birds was reduced at noisy sites, with 14 species avoiding areas surrounding gas compressors. They concluded that altered species interactions may be contributing to the success of species well-adapted to noisy environments and to the decline of species more sensitive to noise. This is also a phenomenon that probably arises in areas exposed to traffic noise (Ref. 1.16).

1.2.14. As stated above, experimental designs have been used in studies to control for potential confounding effects, providing compelling evidence for effects of chronic noise on bird populations. For example, reductions in the overall densities in migrant and breeding bird communities, and in the numbers of male greater sage-grouse attending leks have been demonstrated in relation to experimentally generated anthropogenic noise of various types (e.g. traffic and compressor engine noise) (Ref. 1.33; Ref. 1.34; Ref. 1.2). However, as also noted above, several such studies demonstrate variable responses in the densities or abundance of individual species.

1.2.15. Although much of the work relating to effects of chronic noise concerns songird populations, effects on other bird groups have also been documented, including for greater sage-grouse (as noted above – Ref. 1.33). Hirvonen (2001 - Ref. 1.35) conducted a study on a new road being built in Finland and found that the conservation value of adjacent wetlands decreased due to the loss of several wetland habitat specialist species, including bittern, during and after construction of the road. No detailed mechanism for why these species should have been displaced was determined, but it could have been related to an increase in noise levels, an increase in human activity levels (visual intrusiveness), or a combination of factors. Breeding densities of several meadow-bird species (including some wader and duck species) were found to be lower in proximity of motorways in the Netherlands, but in this study the extent to which these effects were due to noise or visual impacts associated with traffic, or possible habitat variation associated with distance from motorways was unclear (Ref. 1.36). Densities of nesting stone-curlew on areas of suitable nesting habitat in southeast England were also reduced up to at least 1km from major trunk roads, although again the relative importance of noise and visual effects in causing the response is unclear (Ref. 1.37).

1.2.16. Behavioural evidence and studies of other anthropogenic noise sources suggest that road noise should be a major driver of observed road effects. However, although road ecology studies attempting to directly address the effect of traffic noise on wildlife have suggested that noise is a major cause of negative effects, they are typically conducted in the presence of other effects of roads, such as mortality, visual disturbance and edge effects (habitat alteration).

1.2.17. To isolate the potential effects of noise associated with roads, McClure *et al.* 2013 (Ref. 1.34) set up a ‘phantom’ road using an array of speakers broadcasting road noise into a roadless landscape. They recorded a decline of bird abundance of over one-quarter along the phantom road, and the almost complete avoidance of habitat alongside the road by two species of bird. This work suggests that road noise may be a major driver of the documented negative effects of roads on wildlife and, in particular, bird communities.

1.2.18. In relation to the effects of chronic noise on the foraging success of predatory birds, studies have demonstrated effects of traffic noise on prey detectability by nocturnally foraging owls (primarily short-eared and long-eared owls), with the probability of detection of ‘artificial prey rustling sounds’ (aimed at mimicking the sound produced by small mammals walking on the ground) declining from c.0.75 under conditions with background noise levels of 32 dB to c.0.1 at traffic noise levels of 80 dB(A) (Ref. 1.30). Similarly, under experimental conditions, prey capture probabilities by northern saw-whet owls declined from slightly less than 0.2 to nearly zero as the generated noise levels increased from 29 dB(A) to 60 dB(A) (Ref. 1.29). Such effects are likely to be extreme amongst predatory birds because they apply to owls (which are hearing-specialist hunters) hunting in conditions where prey detection relies entirely (or almost entirely) on the use of auditory cues, and where the control (or baseline) noise levels are low (i.e. 32 dB and 29 dB in each of the two studies).

1.2.19. Of particular relevance to this assessment, in relation to potential impacts on wintering waterbirds, is the work undertaken by Briggs 2007 (Ref. 1.38) and Briggs *et al*. 2012 (Ref. 1.39) on the use of waterbodies in the South West London Waterbodies SPA by wintering gadwall and shoveler. While no noise measurements at sites used by wintering birds were undertaken, a number of open water habitats used by both gadwall and shoveler throughout the winter are within 1-4km of Heathrow Airport (e.g. Stanwell Moor, Staines Reservoirs) and immediately under the flight paths of aircraft landing and taking off. Noise contours for these flight path areas show that noise levels (at ground level) are within the range of 60-70dB $LA_{eq}$, so that the $L_{Amax}$ values would be significantly higher than these levels (see below).

### c) Sensitivity thresholds

1.2.20. For the purposes of this assessment, sensitivity thresholds have been based upon impulsive, as opposed to chronic, noise. This is because impulsive noises are considered more likely to lead to behavioural responses by birds, such as ‘escape behaviours’ and the desertion or avoidance of areas, than are equivalent levels of chronic noise (Ref. 1.40). Also, as detailed above, the evidence for chronic noise effects is strongest in relation to songbirds, with considerable variability between species in the extent of response. Sensitivity thresholds at which the onset of noise disturbance may start to lead to potentially deleterious behavioural responses in birds and animals have been developed in respect of impulsive noise levels, with these often focussed on wintering waterbirds.

1.2.21. An experimental study of the response of waterbirds to impulsive noise (an air horn) by Wright *et al*. 2010 (Ref. 1..41) found a statistically significant positive relationship between the sound pressure level (dB(A)) experienced by the birds and the behavioural response observed. This experimental work indicated that intentional disturbance at very low dB(A) levels is highly unlikely to elicit a behavioural response, while at above 65.5 dB(A) a behavioural response of some kind becomes more likely to occur than no response. For sudden unexpected noises in the range of 72-81 dB(A) flight with abandonment is the most likely outcome of disturbance. On the basis of the results of the experiment, Wright *et al.* 2010 (Ref. 1.41) conclude that if non-response and non-flight response are taken to be relatively harmless, and flight responses potentially costly (in terms of energy expenditure), then for the waterbird species studied at the site a costly outcome becomes more likely at noise levels above 70 dB(A). As remote noise-making equipment was not used in the study, it is likely that the observed increase in severity of behavioural responses with noise levels was to some extent confounded by visual stimuli because the increase in noise levels experienced by the birds under study was associated with a closer approach by the recorder (Ref. 1.41). Thus, the conclusions may be conservative in relation to the noise levels which may elicit responses in wintering waterbirds. It is also considered important to note that the study was undertaken using infrequent impulsive noises and therefore, the potential for habituation by birds to the noise stimuli was not explored as part of the study.

1.2.22. Cutts *et al.* 2013 (Ref. 1.40) using a combination of literature review and field observations linked the likely behavioural responses of waterbirds to typical noise levels that may arise during construction works. They categorised disturbance effects into high, moderate or low and linked these to a range of noise levels, as follows:

- **High noise level effects** - noise disturbance is typified by regular responses to stimuli with birds moving away from the works to areas which are less disturbed (within noise tolerances). Most birds will show a degree of response to noise stimuli. Birds that remain in the affected area may not forage efficiently and if there are additional pressures on the birds (cold weather, extreme heat etc.) then this may impact upon the survival of individual birds or their ability to breed. For auditory disturbance to qualify as a high level, it must constitute a sudden noise event of over 60dB (at the bird, not at source) or a more prolonged noise of over 72dB.

- **Moderate noise level effects** - moderate noise disturbance is typified as high-level noise which has occurred over long periods so that birds become habituated to it or lower level noise which causes some disturbance to birds. This encompasses occasional noise events above 55dB, regular noise 60-72dB and long-term regular noise above 72dB, where birds have become habituated. There is cross-over in moderate and high-level noise thresholds although the lower band can be assumed unless the species is particularly sensitive. Those species that are considered particularly sensitive are brent goose, curlew and redshank. Birds that may be more sensitive than average include shelduck & bar-tailed godwit (Ref. 1.20).

- **Low noise level effects** – low level noise is classed as that which is unlikely to cause response in birds using a fronting intertidal area. As such, noises of less than 55dB at the bird are included in this category. These effects are likely to be masked by background inputs in all but the least disturbed areas and thus would not disturb the birds close by. Noise between 55-72dB in some highly disturbed areas (e.g. industrial or urban areas and adjacent to roads) may feature a low level of disturbance provided the noise level was regular as birds will to often habituate to a constant noise level.

1.2.23. Cutts *et al*. 2013 (Ref. 1.40) suggest that the above categorisations may be relatively simplistic and that development specific situations need to be taken into account as well as the known sensitivities of the species under investigation. In respect of this, they note (from observation) that a single sudden sound will generally cause more disturbance than a constant or regular noise regardless of noise level. Habituation to stimuli will also usually entail a reduction in the level of reaction - this applies to both visual and noise related disturbance. An exception to this is if multiple stimuli occur at the same time (e.g. walkers, works and planes). In this case a greater effect (i.e. behavioural response) may arise.

1.2.24. Based on the observed responses of waterbirds (primarily mallard and redshank) to various noise stimuli, Cutts *et al.* 2013 (Ref. 1.40) derive an overview table (TIDE Toolkit) utilising the standard distance decay rates for noise. This enables the calculation of the likely disturbance effect for a noise level and distance of receptor from source – **Plate 1.1**.

1.2.25. In **Plate 1.1**, acceptable ‘dose’ levels (i.e. to 70 dB(A)) are shaded green with dark green unlikely to have any affect whilst the pale green might occasionally induce a low level behavioural response such as a “heads-up”; yellow to orange shading is where a response is likely but mitigation may be effective in reducing the disturbance risk; pale red where mitigation is necessary and might be of value, but with a remaining risk of effect; dark red where a flight response is almost certain to occur and would be increasingly difficult to mitigate.

1.2.26. The values given in **Plate 1.1** are intended to apply to sudden noise levels occurring regularly. Such peak noise levels, which occur for a fraction of a second during a sudden loud event, are described in acoustics by the $L_{Amax}$ parameter. This parameter is commonly used in bird studies (although is not always reported as the $L_{Amax}$ parameter).

1.2.27. In addition to the key $L_{Amax}$ parameter, the overall, typical ambient level also needs to be considered. Ambient noise is described by the LAeq parameter.

### Plate 1.1: Standard distance decay rates for noise – from Ref. 1.40

| Metres from Source | dB(A) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.67 | 120 | 110 | 100 | 95 | 90 | 85 | 80 | 75 | 70 | 65 | 60 |
| 1.33 | 114 | 104 | 94 | 89 | 84 | 79 | 74 | 69 | 64 | 59 | 54 |
| 2.67 | 108 | 98 | 88 | 83 | 78 | 73 | 68 | 63 | 58 | 53 | 48 |
| 5.33 | 102 | 92 | 82 | 77 | 72 | 67 | 62 | 57 | 52 | 47 | 42 |
| 10.67 | 96 | 86 | 76 | 71 | 66 | 61 | 56 | 51 | 46 | 41 | 36 |
| 20.67 | 90 | 80 | 70 | 65 | 60 | 55 | 50 | 45 | 40 | 35 | 30 |
| 42.67 | 84 | 74 | 64 | 59 | 54 | 49 | 44 | 39 | 34 | 29 | 24 |
| 85.33 | 78 | 68 | 58 | 53 | 48 | 43 | 38 | 33 | 28 | 23 | |
| 170.67 | 72 | 62 | 52 | 47 | 42 | 37 | 32 | 27 | 22 | | |
| 341.33 | 66 | 56 | 46 | 41 | 36 | 31 | 26 | 21 | | | |
| 682.66 | 60 | 50 | 40 | 35 | 30 | 25 | 20 | | | | |
| 1365.32 | 54 | 44 | 34 | 49 | 24 | | | | | | |

1.2.28. Advice from the TIDE toolkit and elsewhere suggests that where ambient levels are high, there may be, in effect, a masking of maximum levels. It may be that if the overall increase in (relatively steady) noise level from construction activities is relatively high, birds may react less (or become habituated) to the same peak levels compared to when ambient levels are lower. This may be relevant to some locations close to the construction site during some construction activities/phases.

1.2.29. In this respect, it may be more pertinent to consider LAeq values as representing chronic noise levels that may arise on a daily basis over the duration of the construction period. The predicted $L_{Amax}$ noise levels, given their intermittent and localised nature within the footprint of the development, can be used to determine where, within and around the main development site, thresholds at which behavioural change in birds might be expected to arise. Such behavioural change largely involving avoidance / displacement or localised flight and return once noise levels had dissipated.

1.2.30. On the basis of the information presented in the TIDE Toolkit and Wright et al. 2010 (Ref. 1.41), a 70 dB noise level ($L_{Amax}$) is considered appropriate as a precautionary threshold at which the behavioural response of birds may start to become potentially costly in terms of energy expenditure (as determined above for wintering waterbirds). In other words, this is a threshold at which the potential for adverse effects to individual birds may start to arise and, below this level, significant effects would not be expected (although see above in relation to birds that are attending nesting or breeding sites). It should be noted that a 70 dB threshold has, as a general rule, been in use for a number of years, based on published data as well as findings from primary observations (e.g. Ref. 1.42 and Ref. 1.9). Noise levels at the receptor above 75 - 80 dB $L_{Amax}$ are considered more likely to have an effect that may be of consequence, although, as noted by Cutts et al. 2013 (Ref. 1.40), habituation to such levels can arise.

#### d) Breeding birds

1.2.31. Given that the above threshold is based upon work undertaken on wintering waterbirds, it may not be applicable to breeding waterbirds because the same species may show different sensitivities (in terms of their behavioural response) in different seasons, whilst the mechanisms by which effects of noise disturbance arise may differ between breeding and wintering populations (see above). As indicated above, the available evidence for breeding gulls and terns suggests that for certain species in certain situations (at least) responses occur at noise levels above 70dB $L_{Amax}$, but this evidence derives from colonially nesting species and so may not be directly applicable to the species and populations of interest at SZC (Ref. 1.24, Ref. 1.25, Ref. 1.26). The paucity of evidence relating to breeding waterbirds suggests that, on a precautionary basis, it is appropriate to adopt a lower threshold than is used for wintering waterbirds.

1.2.32. For wintering waterbirds, behavioural responses (of any type) were found to become more likely than no response when noise disturbance was at levels of 65.5dB(A) or above (Ref. 1.41). Thus, 65dB LAmax may be regarded as representing a suitable lower threshold to use for breeding waterbirds, on the basis that it is sufficient to elicit a level of response amongst wintering waterbirds but is below that at which flight responses become most likely (Ref. 1.41). In addition, levels of noise disturbance at the Trimley Marshes reserve (on which waterbirds breed) are known to frequently exceed 65 dB LAmax (Ref. 1.22). As for wintering waterbirds, it is considered that a suitable noise threshold for breeding waterbirds represents a level at which flight responses are expected to become likely because such responses have the potential to lead to effects with population-level consequences (e.g. reductions in breeding productivity).

## 1.3. Visual disturbance evidence base

#### a) Response thresholds and the evidence for defining zones of potential visual impact

1.3.1. A common method used to prescribe ‘acceptable separation distances’ between people and birds is to use one or two measures of disturbance distance: ‘alert distance’ (AD), the distance between the disturbance source and the animal at the point where the animal changes its behaviour in response to the approaching disturbance source, and ‘flight initiation distance’ (FID), the point at which the animal flushes or otherwise moves away from the approaching disturbance source. When used as a criterion to set up minimum approach distances (in relation to feeding or roosting as opposed to nesting waterbirds), flight distance may not be a good indicator of tolerance, since it may be greatly affected by other factors (Ref. 1.43), and it may fail to decrease disturbance because it does not include the area in which birds adapt their response to the source of disturbance.

1.3.2. In respect of wintering waterbirds, Laursen et al. 2005 (Ref. 1.44) observed the following mean escape distances (shortest distance by which birds flush when approached by people) for wildfowl and waders on intertidal mudflats and saltmarsh in the Danish Wadden Sea:

- Curlew – 300 m.
- Pintail – 294 m.
- Wigeon – 269 m.
- Mallard – 236 m.
- Shelduck – 225 m.
- Teal – 197 m.
- Lapwing – 142 m.
- Redshank – 137 m.
- Grey plover – 132 m.
- Black-headed gull – 116 m.
- Dunlin – 70 m.
- Ringed plover – 42 m.

1.3.3. Bregnballe et al. 2009 (Ref. 1.45 and Ref. 1.46) recorded flight escape distances for a number of waterbird species from advancing pedestrians at a nature reserve in Denmark. For birds with unobstructed views the mean escape distances were recorded as 156m for teal, 166m for mallard and 205m for wigeon.

1.3.4. While these observed 'response' distances may vary in relation to a number of factors, such as the time of year, flock size, body condition of the birds and the influence of previous stimuli, they at least provide an indication of the range over which potential human visual disturbance effects may occur for individual species. The alert distances for the species studied by Laursen et al. 2005 (Ref. 1.44) and Bregnballe et al. 2009 (Ref.B45 and Ref. 1.46) would be greater than those of the recorded FIDs. However, there is very limited information on the alert distances of waterbirds and, therefore, the size of any buffer that should be applied to the FID to enable birds to adapt their response to the source of disturbance. Laursen et al. 2005 (Ref. 1.44) suggested taking the variation into account when creating buffer zones. Bregnballe et al. 2009 (Ref. 1.46) suggest that this could be achieved by adding two standard deviations to the mean escape distance. For the waterfowl species that they studied this would result in overall buffer widths of 223m for wigeon, 177m for mallard and 178m for teal. Alternatively, Fernandez-Juricic et al. 2001 (Ref. 1.47) in their study of park-dwelling bird species suggest using the distances at which birds are alerted when planning buffer zones, which was on average 1.5 times longer than the escape distances of the same species (Ref. 1.47). Using the escape distance data from the Bregnballe et al. 2009b (Ref. 1.46) study, this would equate to buffer zones of 300m for wigeon, 249m for mallard and 234m for teal.

1.3.5. A review of FIDs in birds determined mean and maximum average values of 71m and 250m, respectively, for non-nesting wildfowl species (i.e. ducks, geese and swans) from a total of 80 values from 13 different studies, with only three of these values being in excess of 200m (Ref. 1.48). For non-nesting wader species, the mean and maximum average values were 50m and 500m, respectively, from a total of 157 values recorded in 16 different studies (with two and five values in excess of 300m and 200m, respectively). These 'response' distances were recorded in relation to a range of human-related disturbance sources, including dogs, aircraft, motorised vehicles and watercraft, but with the majority attributed to pedestrians. Therefore, in some cases, there would be the potential for confounding effects of noise and visual stimuli in causing the observed bird response. The two largest FID values of 339m and 500m were recorded for Eurasian curlew in response to pedestrians and Eurasian oystercatcher in response to aircraft, respectively (Ref. 1.48).

1.3.6. The FID values recorded for nesting wildfowl and waders in the review by Livesey et al. 2016 (Ref. 1.48) tended to be lower than those for the non-nesting situation, with mean and maximum average values of 52m and 175m, respectively. These estimates are based on only 14 values derived from two different studies, but broadly similar findings have been obtained in most other studies of FIDs for breeding waterbirds.

1.3.7. Thus, flushing distances of less than 100m are reported for nesting New Zealand dotterels, whilst alarm responses of breeding golden plover averaged 187m (suggesting lower FID values) and the highest mean flushing distance amongst 15 species of nesting waders and waterbirds in Florida in relation to approaching pedestrians or boats was 32m (Ref. 1.49; Ref. 1.50; Ref. 1.51). Also, Ruddock and Whitfield 2007 (Ref. 1.52) report median FIDs for five different wader and waterbird species during both incubation and chick-rearing, with all values being 300m or less (although sample sizes are small for some species). Breeding stone-curlew were found to show active responses (i.e. running or flying) to disturbance sources at distances of up to 500m, although the mean (or median) distances at which such responses occurred is unclear (Ref. 1.53). For a given distance to the disturbance source, the likelihood of such responses by stone-curlews was greatest for approaching people with a dog and least for a vehicle (with approaching people without a dog being intermediate).

1.3.8. Based on data from the above studies, it is apparent that the disturbance response of waterbirds to human activity is variable. However, for the majority of waterbird species, flight initiation in the non-breeding season is likely to occur at distances of less than 200m of the source of the disturbance, with evidence that it will often occur at lesser distances for birds on their nesting or breeding territories. The findings of Laursen et al. 2005 (Ref. 1.44) and Bregnballe et al. 2009 (Ref. 1.45 and Ref. 1.46) can also be used as an indication of the sensitivity of waterbird species to potential disturbance. It should be noted, however, that the flight escape distances observed in these studies are associated with direct human activity and movement or approach rather than the movement of machinery and vehicles. It is possible that mean escape distances or FIDs may be lower in relation to certain types of machinery and vehicles, given that human presence would be not be as discernible to birds (as is suggested by the transport disturbance studies undertaken by McLeod et al. 2013 (Ref. 1.54) and the stone-curlew study by Taylor et al. 2007 (Ref. 1.53).

1.3.9. The presence of man-made structures may also act as a visual disturbance cue to birds, leading to the avoidance of areas around structures. Evidence specifically relating to the disturbance effects of immobile towers or cranes on waterbird species is lacking. However, a significant amount of work has been undertaken on the disturbance / displacement effects of onshore wind turbines.

1.3.10. Waterbirds may show avoidance of wind turbines during both the breeding and non-breeding seasons, although findings are variable between species and sometimes between studies of the same species. For eight wader and waterfowl species or groups (i.e. goose species) in the non-breeding season, all but one (oystercatcher) showed evidence of avoidance in the majority of wind farm impact studies reviewed by Hötker et al. 2006 (Ref. 1.55). Avoidance distances were greatest for goose species, with median and mean minimum distances to turbines of 300m and 375m, respectively, and values of greater than 600m recorded in some studies. Most other species considered in the review tended to show mean and median minimum distances to turbines of approximately 150m to 250m during the non-breeding season (Ref. 1.55). Based on these findings, Hötker et al. 2006 (Ref. 1.55) suggest that important roosting areas for waders and wildfowl should be kept free of wind farms, with a buffer of at least 400m for waterfowl generally, and at least 500m for goose roosts (noting that these buffer distances are disturbance free distances for roost sites, rather than applying to feeding areas). In other studies of wintering geese, average displacement distances of 100m for wind turbines in lines and of 200m for turbines in clusters have been observed for pink-footed geese in Denmark (Ref. 1.56).

1.3.11. Of four breeding wader species considered by Hötker et al. 2006 (Ref. 1.55), all showed evidence of avoidance in the majority of wind farm impact studies reviewed, although in two cases (black-tailed godwit and oystercatcher) there were almost as many studies indicating no, or positive, effects on densities. Mean and median minimum distances to turbines for these breeding waders tended to range from approximately 100m to 250m (with the higher values recorded for black-tailed godwit considered less reliable, as they may have been a consequence of the relatively rarity of this species - Ref. 1.55). A large-scale comparative study in the UK uplands also documented reduced densities of breeding waders in proximity to onshore wind farms, with effects on distribution apparent up to distances of approximately 400m for most species, and up to 800m for curlew (Ref. 1.56). However, studies comparing sites before and after wind farm operation (sometimes associated with simultaneous comparisons on control sites to provide Before-After-Control-Impact (BACI) designs) have tended to find conflicting evidence for effects of turbines on the densities and distribution of breeding waders, including for curlew (Ref. 1.57; Ref. 1.58; Ref. 1.59; Ref. 1.60; Ref. 1.61).

1.3.12. Based on the available evidence from disturbance studies and the potential complexity of defining disturbance zones for individual species, which show variability of response to sources of disturbance, a zone of sensitivity to disturbance of 300m from potential sources of activity and visual intrusion is considered precautionary. As such, this is considered to be an appropriate buffer distance in situations where the activities in question are visible to the birds using the potentially affected areas. However, where visibility is obscured by screening or as a result of the topographical and habitat conditions on the site, reduced buffer distances are likely to be appropriate.

1.3.13. This definition for this zone of sensitivity to sources of activity and visual intrusion (subsequently termed the ‘potential visual impact zone’) is considered to encompass the occurrence of tall structures (e.g. cranes) within the main development site. Although the evidence presented above suggests that displacement of waterbirds by onshore wind turbines may extend beyond 300m, it also demonstrates considerable variability in such responses (particularly amongst breeding populations). Furthermore, it cannot be assumed that the occurrence of tall structures within the main development site will represent an equivalent visual impact to that produced by a wind turbine array. It is considered highly likely that the size and number of turbines that may constitute an onshore wind farm, together with the movement from the rotation of the turbine blades, will mean that the visual impact from an onshore wind farm is greater than that associated with tall structures that may be present within the main development site during construction. As such, it is considered likely that any impacts on waterbirds would extend over shorter distances.

#### b) Artificial lighting

1.3.14. Artificial lighting would also be associated with the construction-related activities and may act as a potential form of visual disturbance. Many species of geese and ducks forage at night (Ref. 1.62) with evidence to suggest that nocturnal feeding seems often to be actively preferred, either because daytime feeding is too disturbed or dangerous, or because night feeding is more profitable. Ducks that normally forage more at night than by day include teal, gadwall, mallard and pintail and many wildfowl take advantage of moonlight to increase foraging opportunities. McNeil et al. 1992 (Ref. 1.62) note that daytime foraging is performed in habitats where waterfowl are often subject to various kinds of disturbance and to terrestrial or aerial predators. Surface feeding ducks, when up-ending, may be particularly vulnerable to predation during the day as they cannot see approaching predators.

1.3.15. As many waterbird species show a preference for nocturnal feeding, the influence of artificial lighting on this activity needs to be considered. Artificial lighting of habitats used by waterbirds occurs in many areas, particularly developed coastal and estuarine sites. The effects of lighting have been studied for a number of species. Dwyer et al. 2012 (Ref. 1.63) showed that ambient light levels affect the timing and distribution of foraging opportunities for wintering redshank on the intertidal mudflats of the Forth Estuary. Based on field data they conclude that light emitted from an industrial complex improved nocturnal visibility for redshank. The increased light levels allowed sight-based foraging in place of tactile foraging, which implied both a preference for sight-feeding and enhanced night-time foraging opportunities under these conditions.

1.3.16. Santos et al. 2010 (Ref. 1.64) found that artificial illumination caused a considerable increase in the use of tidal areas by waders, and significant changes in their foraging behaviour at night. Prey intake rate in illuminated areas increased 78% across all studied wader species as birds shifted from tactile to sight-based foraging. While, for foraging birds, there may be some negative effects, such as prey depletion, exposure to greater disturbance pressure (particularly in urban areas) and an increase in vulnerability to nocturnal predators, Santos et al. 2010 (Ref. 1.64) conclude that artificial illumination may, overall, help to improve foraging conditions for waders in intertidal areas.

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# Appendix 14B2.3: Evidence base for potential effects of anthropogenic disturbance (noise and visual disturbance) on marsh harrier

## 1.1. Noise disturbance evidence base

### a) Introduction

1.1.1. There are no available studies that provide specific information on the behavioural responses of marsh harrier to anthropogenic noise (although observations of marsh harrier flight activity at Trimley Marshes, in relation to noise generation from the adjacent Port of Felixstowe, have been undertaken to inform the current assessment – see below). By necessity, the assessment of the likely response of marsh harrier has to be undertaken through inference with regard to observed effects on other bird species. Information and evidence from studies on other species of birds, including raptors and owls where such information is available, is therefore presented here.

1.1.2. As set out for breeding avocet, because of their reliance on acoustic communication, birds have been viewed as potentially vulnerable to changes in their noise environment that may be caused by anthropogenic activity. Studies suggest that noise may disrupt acoustic communication, interfere with detection of warning signals or prey and elevate stress levels. In this respect, harriers (i.e. species belonging to the genus Circus) are notable for having anatomical features, and sometimes using hunting strategies, that are associated with greater reliance on aural detection of prey than is typical of other raptors. Experiments on northern harriers have demonstrated that the directional hearing of this species is similar to that of owls and substantially better than for other diurnal raptor species (Ref. 1..1). Amongst the different harrier species, the reliance on aural detection of prey may be less marked in marsh harriers due their tendency to forage at greater flight heights, whilst, as in Montagu's harrier (but in contrast to some other harrier species), the ruff is restricted to the arc behind each ear opening, again possibly indicating reduced reliance on aural detection of prey (Ref. 1.2). Also, reliance on auditory cues is likely to be greatest when hunting small mammals or other small-sized prey in dense vegetation, whereas the main prey groups of marsh harriers in the Minsmere-Sizewell area are likely to be gamebirds, waterbirds, rabbits and, to a lesser extent, small birds (see above).

1.1.3. Noise has been associated with declining bird densities as a result of displacement from otherwise suitable habitat due to ecological sensitivities or intolerance to noise.

1.1.4. Chronic (largely non-impulsive) anthropogenic noise from busy roads, urban areas, and permanent industrial structures has also been implicated in detrimental impacts upon breeding bird populations. However, its specific effects on species populations and communities may be difficult to determine due to the complex behavioural responses of birds to such signals, including selective avoidance and habituation, and the role that other factors such as changes in habitat and visual disturbance associated with human activities may also play.

#### b) Impulsive-type construction noise

1.1.5. High levels of tolerance to aircraft and missile bombing was recorded in one study of northern harrier where a harrier continued hunting during target practice, suspected to be capturing small birds flushed from cover by the bombings (Ref. 1.3). The noise levels in the study were in the range 80 - 87 dB (although it is not known what parameter was used to assess this) and the closest explosions occurred at 60m from the foraging bird.

1.1.6. Further background information on impulsive-type construction noise and chronic noise disturbance is provided in **Appendix 2** (covering work by IECS, studies on waterbirds in the Waddenzee, work by Habib et al. (2007) (Ref. 1.4), Hirvonen (2001) (Ref. 1.5) and McClure et al. (2013) (Ref. 1.6)). Sensitivity thresholds are also discussed in this section; while further information specific to marsh harrier is presented below.

#### c) Sensitivity thresholds

1.1.7. To provide an indication of whether a 70 dB ($L_{Amax}$) threshold is appropriate to foraging marsh harrier, survey work was undertaken at the Suffolk Wildlife Trust's Trimley Marshes reserve, which is used by foraging marsh harriers and is adjacent to the Port of Felixstowe. This involved simultaneously monitoring marsh harrier flight activity and noise levels in June 2016, when marsh harriers not only foraged over the marshes but also bred at the site, rearing two chicks (Ref. 1.7).

1.1.8. This monitoring revealed that maximum noise levels at the Trimley Marshes site from the port activities are variable but, on some days, can exceed 70 dB, $L_{Amax}$ one to three times an hour and 65 dB, $L_{Amax}$ 10 times an hour. On this basis, it is considered likely that a high proportion of the site would occur within a contour that encompasses the 65 dB, $L_{Amax}$ noise level, whilst some would be within the contour for 70 dB, $L_{Amax}$ (Ref. 1.7).

1.1.9. Surveys of marsh harrier flight activity (undertaken using analogous methods to those used in the current assessment – see below) recorded higher levels of flight activity across the Trimley Marshes (based on a total of 27 hours of survey) than those recorded for the Minsmere South Levels (see below). This is unsurprising, given that the harriers were nesting within Trimley Marshes (whilst the data are not directly comparable because only a relatively short period of the breeding season was covered by the Trimley Marshes surveys) but, nonetheless, suggests a tolerance of these noise levels by foraging marsh harriers (Ref. 1.7). Foraging marsh harriers were not observed to react to impulsive noise events noted during the surveys. On one occasion a measured impulsive noise event of 68 dB, $L_{Amax}$ coincided with an observed marsh harrier flight, with no apparent response from the harrier, whilst on several other occasions marsh harrier flights were recorded a short time after impulsive noise events above 65 dB, $L_{Amax}$, indicating that such noise events did not cause displacement of foraging harriers from the area (Ref. 1.7).

1.1.10. Although the surveys at Trimley Marshes did not measure actual foraging activity or foraging success by marsh harrier, it is notable that the observed birds were described as actively hunting or foraging in over one third of the flight records during these surveys, suggesting that the Trimley Marshes is used extensively for this purpose (Ref. 1.7). Furthermore, Trimley Marshes is regarded as holding an abundance of breeding, wintering and passage wetland birds[9], which would suggest that there is little evidence for major effects of noise disturbance on the available prey resource for marsh harriers at this site.

1.1.11. As described above, chronic noise disturbance can affect hunting success in owls (Ref. 1.8, Ref. 1.9). Although harrier species tend to rely on aural detection of prey to a greater extent than do other diurnally active raptors (Ref. 1.10), the findings from these studies on owls are likely to have limited applicability when considering the potential effects of noise disturbance on marsh harriers. This is because these findings relate to situations where birds are entirely (or almost entirely) reliant on hearing for prey detection and where the control (or baseline) noise levels are particularly low. In addition, nocturnally foraging owls hunt more efficiently when conditions are more conducive to visual detection of prey (Clarke 1983) so that effects of noise disturbance on hunting success should be less marked in such situations, whilst the dependence of marsh harrier on auditory cues will be considerably less than for owls (see above).

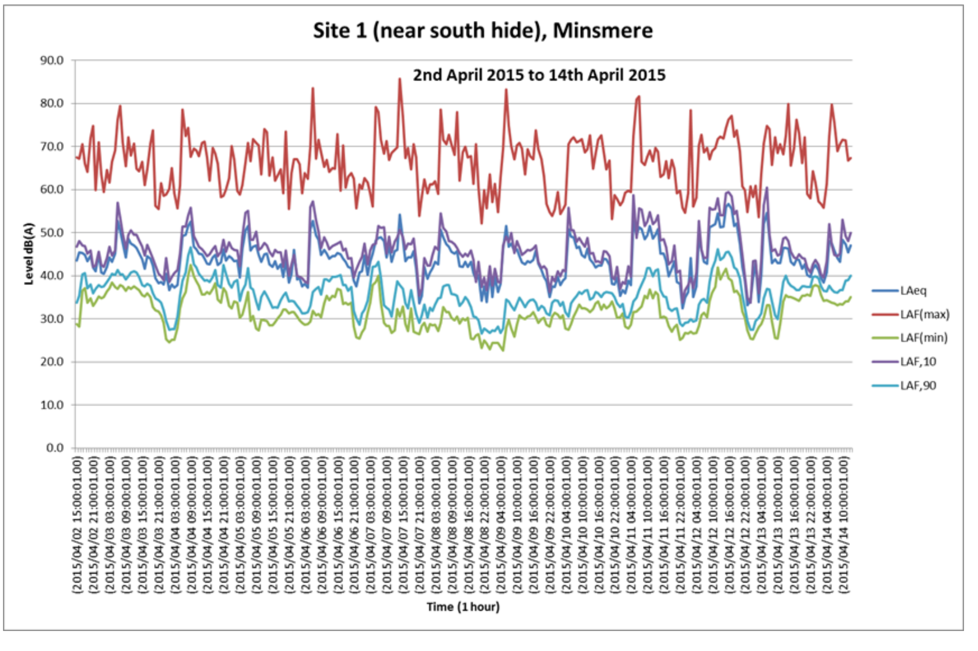
1.1.12. With regard to the adoption of the 70 dB $L_{Amax}$ threshold, surveys of noise levels have been undertaken at several locations in the vicinity of the main development site and the wider area used by breeding marsh harriers from the Minsmere-Walberswick SPA. These data are considered to provide context on the types of background noise levels currently experienced in this area.

[9] https://www.suffolkwildlifetrust.org/trimleymarshes

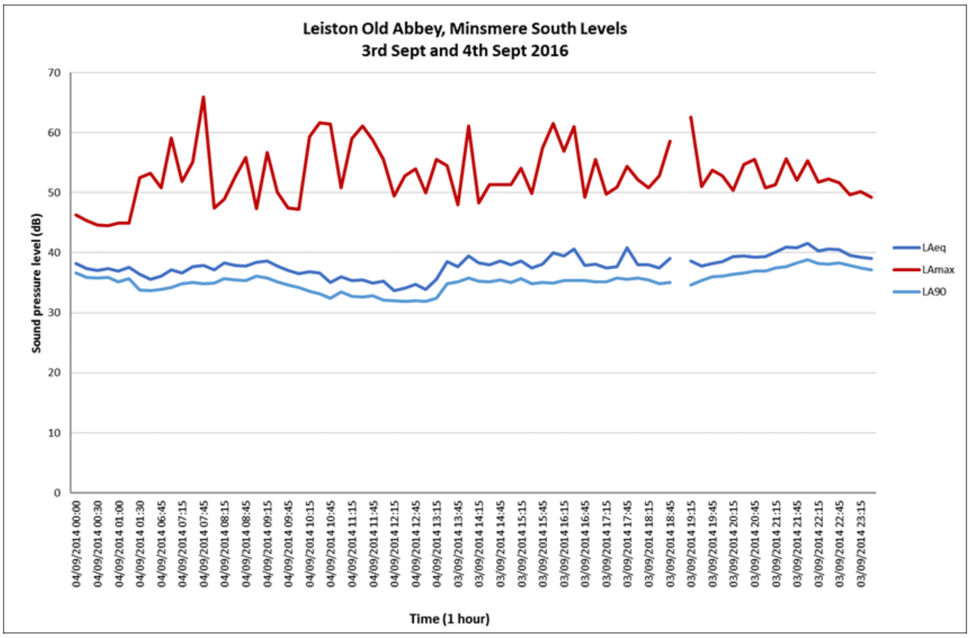
1.1.13. The longest run of such data is from April 2015, at a location within the RSPB Minsmere Reserve where regular occurrences of noise levels between 70 - 80 dB $L_{Amax}$ were recorded (**Plate 1.1a**). These noise levels were associated with both birdsong / calls and anthropogenic activities (e.g. motor vehicles, visitors). Breeding birds at Minsmere, including marsh harrier, may therefore currently experience maximum levels of sound in excess of 70 dB $L_{Amax}$ on occasion during the day. However, as this location is close to a visitor route through part of the reserve it may not be representative of the wider areas used by marsh harrier within the reserve. Shorter runs of data were collected at other locations, including from near Leiston Old Abbey in the Minsmere South Levels during two days in early September and one day in mid-November in 2014, and from a location within the marsh harrier habitat improvement area (see below) during mid September 2016. Noise levels in these locations were associated with sources such as occasional people walking past, agricultural activity, overhead aircraft, insects and birdsong and were often above 60 dB $L_{Amax}$ and occasionally close to, or above, 70 dB $L_{Amax}$ during daylight hours (**Plate 1.1b** and **Plate 1.1c**).

**Plate 1.1: Hourly noise readings taken from (a) near South Hide, Minsmere over approximately two weeks in April 2015; (b) near Leiston Old Abbey in the Minsmere South Levels, from 3rd – 4th September 2016; and (c) within the marsh harrier habitat improvement area, from 12th – 23rd September 2016**

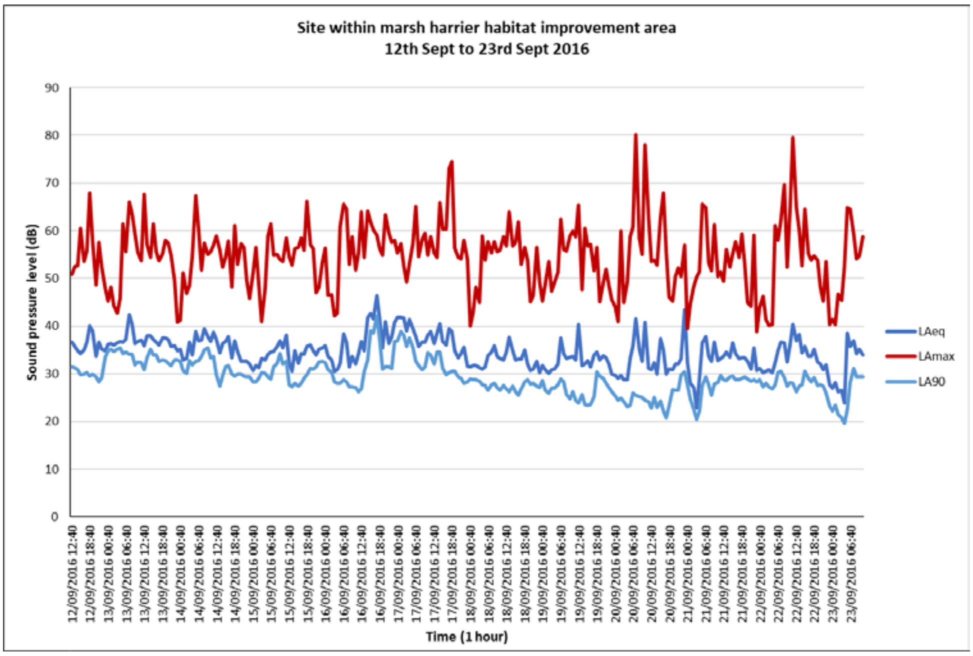
**(a)**



**(b)**


Leiston Old Abbey, Minsmere South Levels
3rd Sept and 4th Sept 2016
Sound pressure level (dB)
70
60
50
40
30
20
10
0
Time (1 hour)
LAeq
LAmax
LA90

**(c)**


Site within marsh harrier habitat improvement area
12th Sept to 23rd Sept 2016
Sound pressure level (dB)
90
80
70
60
50
40
30
20
10
0
Time (1 hour)
LAeq
LAmax
LA90

## 1.2. Visual disturbance evidence base

1.2.1. As discussed above, the role that visual disturbance from the presence of humans and human activities may play in disturbance to birds is often conflated with the effects of noise. There are, however, a number of studies that provide information on the role of human disturbance in the distribution and breeding ecology of marsh harriers, and this has been shown to be a potential problem for marsh harriers during the breeding season, with a study in East Anglia attributing 8.7% of nest failures to human disturbance (Ref. 1.11).

1.2.2. A study by Fernadez and Azcona (1993) (Ref. 1.12) looked in detail at the impacts of human disturbance on breeding marsh harrier. They found that the number of food items and time spent by male and female harriers at the nest decreased during periods of disturbance. However, breeding success was unaffected when comparing disturbed pairs and undisturbed pairs, indicating that the harriers were able to offset the effects of disturbance to some extent at least. The chicks from disturbed nests had higher levels of malnutrition, however, suggesting that survival rates of fledglings could be lower. There was also evidence that the regular presence of crayfish trappers near to breeding sites caused harriers to become habituated, with only limited displacement. This is thought to be because the crayfish trappers were visiting the same sites each day.

1.2.3. Based on available studies and an expert opinion survey, Ruddock and Whitfield (2007) (Ref. 1.13) suggest that for marsh harrier 300 – 500m is an adequate buffer from breeding sites to avoid the adverse effects of human disturbance (visual / activity). The upper buffer value correlates with the distance at which Fernandez and Azkona (1993) (Ref. 1.12) made their behavioural observations. Ruddock and Whitfield (2007) (Ref. 1.13) note that there is a degree of protection offered by the reedbed environment which reduces both the visible detection of disturbance by the birds and the likelihood of ‘casual’ human disturbance. The reedbed nest site means that marsh harriers are likely to flush most frequently at close range whilst on the nest, although birds may detect the disturbance source at a greater distance and prior to flushing.

1.2.4. Madders and Whitfield (2006) (Ref. 1.14) provide a review of the displacement effects of upland wind farms on the foraging behaviour of raptors. They conclude that, in general, most research tends to show that disturbance of raptors at wind farms is negligible. Studies quoted in Madders and Whitfield indicate that the response of hen harriers to the presence of wind farms may vary with no indication of displacement being recorded at several wind farms. Madders and Whitfield (2006) (Ref. 1.14) also state that *“preliminary results at Argyll and Northern Ireland sites suggest foraging may* *be little affected, but local displacement of nesting attempts may occur in the order of 200–300 m around turbines (Natural Research, unpubl. data)".*

1.2.5. Madders and Whitfield (2006) (Ref. 1.14) consider that marsh harriers have a low sensitivity to displacement (from the effects of operational wind farms), less than that observed for hen harrier.

1.2.6. Alves et al. (2014) (Ref. 1.15) in a study of the habitat use of marsh harrier in western Portugal found that human disturbance variables, such as agricultural machinery, constructions, road occupancy and cattle, presented a general negative effecreft on marsh harriers. This is in contrast to other studies (e.g. Ref. 1.16) which found no relationship between human pressure and nesting-site occupancy. However, Alves et al. (2014) (Ref. 1.15) report observations showing clear disturbance and avoidance behaviour of birds when, for instance, farmers and machines were operating in the area. Roads were found to have a significant negative influence on the presence of marsh harriers during the breeding period, but a positive effect during the non-breeding period, suggesting that the population they studied may be sensitive to this type of human pressure only during reproduction. Alves et al. (2014) (Ref. 1.15) suggest that the presence of other raptors using roadside habitats as a foraging resource may have led to territoriality or other competition behaviours towards marsh harriers, possibly causing the observed negative influence during the breeding period. The degree of disturbance caused by other human constructions, such as houses or warehouses, showed little or no relevance in the results, but it is possible that disturbance factors associated with their presence (and human activity in general) could affect reproductive success (Ref. 1.12).

1.2.7. No information relating to potential disturbance of marsh harrier caused by lighting has been identified. However, as marsh harrier is diurnal and typically most active at around dawn and dusk, lighting is considered to be unlikely to constitute an important source of disturbance, even in the absence of any lighting mitigation.

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